USA National Phenology Network






The National Phenology Monitoring System, v0.1

USA-NPN Technical Series 2010-001

USA-National Phenology Network

The National Phenology Monitoring System, v0.1

Authors:

Kathryn A. Thomas[1], Ellen G. Denny[2], Abraham J. Miller-Rushing[3], Theresa M. Crimmins[4], and Jake F. Weltzin[5]

[1] Science Associate, USA-NPN/U.S. Geological Survey Southwest Biological Science Center

[2] Monitoring Design Specialist, USA-NPN/NE-Regional Phenology Network

[3] Associate Director/Program Manager, USA-NPN/The Wildlife Society

[4] Partnership Coordinator, USA-NPN/University of Arizona

[5] Executive Director, USA-NPN /U.S. Geological Survey

USA-NPN Technical Publication 2010-001

Suggested Citation: Thomas, K.A., E.G. Denny, A.J. Miller-Rushing, T.M. Crimmins, and J.F. Weltzin. 2010. The National Phenology Monitoring System v0.1. USA-NPN Technical Series 2010-001. *www.usanpn.org*

This report complies with US Geological Survey Fundamental Science Practice standards. It has undergone peer and policy review and approval.

Contents

Figures

Tables

The National Phenology Monitoring System: Plant Phenology Monitoring 2009

Executive summary

The USA-National Phenology Network (USA-NPN) seeks to engage volunteer observers to collect phenological observations of plants and animals using consistent standards and to contribute their observations to a national data repository. To guide the effort, the USA-NPN National Coordinating Office (NCO) has developed phenology monitoring protocols, articulated in the National Phenology Monitoring System (NPMS), and an information management system, the National Phenology Information Management System (NPIMS), that houses a data repository, the National Phenology Database (NPD). In March 2009, the NCO implemented an online monitoring program for plants, using the NPMS v0.1. As well as providing standards for selecting and setting up a sampling site, the online USA-NPN site provided protocols for observation of the phenophase status of 213 plants. A species profile page, prepared for each species, presented some basic information and the phenophase definitions appropriate for that species. In addition, the website presented tools for observers to report their site observations. In 2009, a total of 2,154 observers registered online and 547, 25.4% of those registered, reported observations on 133 plant species.

What is phenology?

Phenology refers to recurring plant and animal life cycle stages, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. It is also the study of these recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate. Non-biological systems also exhibit annual or periodic stages coupled with changes in environmental conditions (e.g. ice-out of lakes and rivers); although sometimes scientific literature refer to these phenomena as phenology, we reserve the term phenology for biological events, and the term seasonality for non-biological events.

The Intergovernmental Panel on Climate Change report (Rosenzweig et al. 2007) notes that plants and animals respond to changes beyond their tolerances by shifting the timing of life-cycle events, shifting range boundaries, changing morphology, or becoming extirpated or extinct. The report states that 'phenology ……is perhaps the simplest process in which to track changes in the ecology of species in response to climate change.' Understanding the phenology of a species includes understanding the influence of seasonal and interannual variation in climate on the life-cycle events and activities of the species.

People have observed and responded to phenological events long before written history as part of their day-to-day activities, yet in the contemporary era people are often unaware of or overlook the importance of phenology in their everyday lives. Current understanding of phenology is important for society to identify how species are responding to climate change and to plan for how these changes might affect activities such as resource management, public health planning, agriculture and range management, and recreational/tourism marketing.

The USA-National Phenology Network

In response to the growing need to understand the response of plant and animal species to climate change and to develop a widespread baseline against which future phenological change may be measured, a consortium of scientists and agencies organized the USA-NPN. The Network was based upon the historical lilac network maintained by Dr. Mark Schwartz in the University of Wisconsin-Milwaukee's Indicator Observation Program (see 'History of Lilac and Honeysuckle Phenological Observations in the USA', *http://www.usanpn.org/?q=node/36*). Implementation meetings held in 2005 and 2006 resulted in establishment of the USA-NPN NCO and the hiring of its first Executive Director, Dr. Jake Weltzin in 2007. The NCO is located in Tucson, Arizona at the University of Arizona as established by a cooperative agreement between the University and the U.S. Geological Survey (USGS). Funding from the USGS, The Wildlife Society, and the University of Arizona supported NCO staff in 2008 and 2009.

The mission and vision of the USA-NPN describe its activities and purpose:

- Mission statement: The USA-NPN serves science and society by promoting broad understanding of plant and animal phenology and its relationship with environmental change. The Network is a consortium of individuals and organizations that collect, share, and use phenology data, models, and related information
- Vision statement: The USA-NPN encourages people of all ages and backgrounds to observe and record phenologies as tools to discover and explore the nature and pace of our dynamic world. The Network makes phenology data, models, and related information freely available to empower scientists, resource managers and the public in decision-making and adaptation in response to variable and changing climates and environments (Figure 1).

Figure 1. The USA-NPN consists of many partners, including citizen scientists, resource managers, educators, and scientists from organizations including public agencies, Native American tribes, non-governmental organizations, specialized networks, and academic institutions. The USA-NPN National Coordinating Office (NCO) is a coordination and resource center working to advance the mission of the USA-NPN. The NCO, the Board of Directors, and partnering organizations and individuals together comprise the USA-NPN.

The USA-NPN NCO facilitates the activities of the Network through provision of products and services. In 2009, the NCO developed a strategic plan for its activities from 2010-2015. Within the strategic plan, the NCO identifies its functions as:

1. Designing and maintaining the National Phenology Information Management System (NPIMS) and its component National Phenology Database
2. Developing and promoting the National Phenology Monitoring System (NPMS)
3. Facilitating collaborative partnerships within the USA-NPN
4. Providing outreach and education on phenology monitoring
5. Supporting phenology research
6. Promoting application of phenology science and information toward decision support

The NPIMS, NPMS, and facilitation of collaborative partnerships support the development and application of phenological data and information toward the outreach, education, research, and decision support goals of the Network.

Plant Phenology Monitoring: 2009

An essential activity of USA-NPN is the acquisition, archiving, and management of contemporary and historical phenology data. The NCO promotes the NPMS, which, when implemented across the nation, will facilitate the widespread collection of integrated, standardized, high-quality observations of plants, animals, and related biophysical factors. Data collected using this system or integrated within this system provide a valuable resource for research, decision support, and educational purposes.

The NCO has developed the framework for the USA National Phenology Monitoring System with the following principles in mind:

1. Utilize the phenophase as a standard unit of observation and maintain uniformity and simplicity within phenophase definitions to facilitate comparisons across taxa.
2. Promote the collection of high-quality observation data that is broadly useful for a variety of purposes by capturing uncertainty in reporting and by including mechanisms to evaluate observer skill and to infer the quality of their data.

3. Use standardized definitions and crosswalks to maximize the integration of contemporary phenology observations with legacy phenology data collected with common historical methods.
4. Incorporate flexibility to accommodate different levels of observer skill and commitment, different degrees of site accessibility, and different data collection technologies in order to maximize spatial and temporal coverage of observation data.

The USA-NPN Species Protocol Working Group (SPWG) conducted initial work toward developing a National Phenology Monitoring System. The SPWG originated in the 2005 implementation meeting and convened in 2006, 2007, and 2008 to develop criteria for recommended plant species and recommendations for phenology monitoring. Appendix A lists participants in the SPWG. The NCO incorporated recommendations of the SPWG into the NPMS framework.

Phenology monitoring approaches

The NCO has identified two major approaches to monitoring and recording the phenology of individual plants: phenophase status and phenological event. Field observations of individual plants using the two approaches yield different types and amounts of phenology data.

Phenophase status monitoring: The phenophase status approach provides a framework for observing and recording the status of the phenology of a plant throughout the year. Each organism has a suite of potential phenophases that can be observed at each sample date. The observer indicates 'yes' if the phenophase is occurring or 'no' if it is not (Figure 2). Alternatively, the observer may not look for a particular phenophase on a given date, and can indicate this in their reported observations.

Phenophase status monitoring is the NCO recommended monitoring approach. It is data rich; the approach provides information on both the absence of a phenophase and the sampling intensity for that organism. The status approach allows strong information linkage between plant and animal phenology; it provides information on the duration of a phenophase; and, it readily links with other information such as weather data.

Figure 2. An example of how an observer reports observation data for a hypothetical individual deciduous tree using the phenophase status approach. For every visit the observer notes a 'yes', 'no', or 'did not check' for all phenophases defined for the tree. The online species profiles lists the phenophase definitions for each 'Do you see…' question. The colored bars indicate the duration of a phenophase for this tree. Phenophase status monitoring is able to capture duration and repeated occurrence of a phenophase such as for the 'Emerging leaves' and 'Open flowers' phenophases for this tree. If the phenological event monitoring approach was applied to this tree, only the first 'Yes' for each phenophase would be recorded and then observations for that phenophase would be discontinued.

KEY: N=No Y=Yes ?=Did not check

	Do you see...	2-Apr	5-Apr	8-Apr	11-Apr	14-Apr	19-Apr	20-Apr	23-Apr	26-Apr	1-May	3-May	5-May	8-May
Phenophases	Emerging leaves?	N	Y	Y	N	Y	Y	N	N	?	N	N	N	N
	Unfolded leaves?	N	N	Y	N	N	Y	Y	Y	?	Y	Y	Y	N
	≥75% of full leaf size?	N	N	N	N	N	N	Y	Y	?	Y	Y	Y	N
	≥50% of leaves colored?	N	N	N	N	N	N	N	N	?	N	Y	Y	N
	All leaves colored?	N	N	N	N	N	N	N	N	?	N	N	Y	N
	≥50% of leaves fallen?	N	N	N	N	N	N	N	N	?	N	N	Y	N
	All leaves fallen?	N	N	N	N	N	N	N	N	?	N	N	N	Y
	Open flowers?	N	N	N	N	Y	N	N	N	Y	Y	Y	N	N
	Full flowering?	N	N	N	N	N	N	N	N	Y	N	N	N	N
	Ripe fruit?	N	N	N	N	N	N	Y	Y	Y	?	Y	Y	N

In 2009, the phenophase status monitoring protocols consisted of phenophase definitions (Table 1) assigned to physiognomic groups of plants (Appendix B). The NCO made the phenophase status approach available online on 2 March 2009 as an implementation of the NPMS (v0.1). (A pilot version of the NPMS was available for limited beta testing in 2008). Observers use a personalized online account (MyNPN) to access a data registry interface that allows direct incorporation of observation reports into the National Phenology Database.

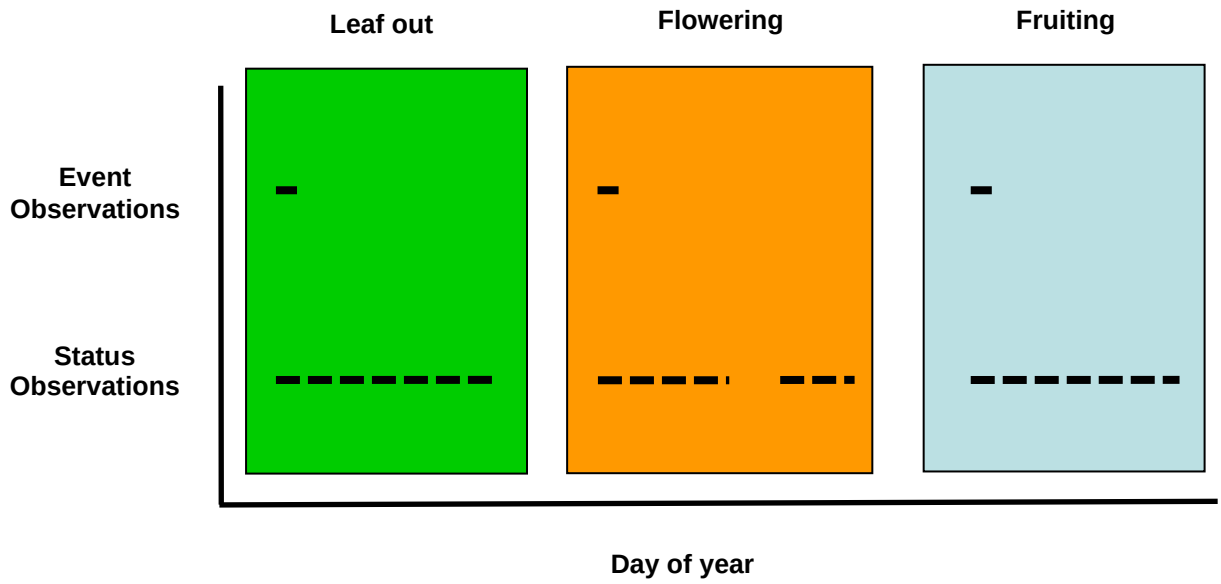
Phenological event monitoring: The phenological event approach to plant monitoring is a traditional method, and is often described using the European based Bilogische Bundesanstalt Bundessortenamt and Chemical Industry (BBCH) coding (Meier 2001). With this approach, the observer watches for a defined phenological event that occurs during the life cycle of the plant. The observation of life cycle event using the phenological event approach results in one data record compared to the multiple data records for the same event observed with the phenophase status monitoring approach (Figure 3).

Table 1. General phenophases of the NPMS plant phenology protocols in 2009*

Phenophases	Deciduous trees and shrubs (with flowers)	Deciduous trees and shrubs (with catkins)	Broadleaf evergreen trees and shrubs	Conifers	Herbs	Grasses	Cacti	Cloned (lilac and honeysuckle)
emerging growth					X	X		
emerging needles				X				
young unfolded needles				X				
emerging leaves	X	X	X					X
young unfolded leaves			X					
unfolded leaves	X	X			X	X		
≥75% of full leaf size	X	X						
all leaves emerged								X
≥50% of leaves colored	X	X						
all leaves colored	X	X						
≥50% of leaves fallen	X	X						
all leaves fallen	X	X						
all leaves withered					X	X		
flower buds							X	
open flowers	X		X		X	X	X	X
full flowering	X		X					X
end of flowering								X
pollen release		X		X				
full pollen release		X		X				
ripe seed cones				X				
ripe fruits	X	X	X		X		X	
ripe seeds						X		

* Modifications to the general phenophases were made for some species; see Appendix B.

Figure 3. The observation of a phenophase using the phenological event approach (Event Observations) results in an observation record at a single time compared to the multiple observation times for the same phenophase observed using the phenophase status monitoring approach (Status Observations).



A phenological event is usually defined as the first day the defined event occurs, such as the first day of flowering, and the observer reports the date of his or her first observation of the event. If the observer has been infrequent in his or her observations, then the actual first day of the event may be earlier than the report given by the observer of the event.

Data collected using the event approach can be shared within the NPIMS through a separate data registry tool for historical and contemporary data. Phenological event observations relate to phenological status observations and the NCO has developed a crosswalk (a relational mapping) relating the 2009 status phenophases with corresponding phenological events and their BBCH codes (Appendix B). Timing of defined phenological events can also be determined using the phenophase status monitoring approach. In this case, the event date is the first positive report for a phenophase following reports of absence of the phenophase in the days preceding its occurrence. This approach provides more certainty of the actual date of the defined event than with phenological event approach because the observer reports status of phenophase observations prior to the report of the event occurring.

Recommended species

The NCO provided a list of 213 plant species recommended for phenology monitoring in 2009 (Appendix C). The list in 2009 consisted of 20 "calibration" species (described below), 2 species within the Cloned Plant Project, 175 regionally important species, and 16 special project species.

The SPWG developed the initial rationale for recommended species and an initial list of recommended species in 2008. Representatives of NEON, the National Park Service, and biological field stations vetted the rationale and list. The SPWG made some modifications to the initial list after scientist and agency reviewers responded with criticisms and suggestions. Documentation of their work in 2008 is described in 'Development, Rationale, and Vetting of the USA-NPN Plant Species List, 2008' (*http://www.usanpn.org/files/shared/files/PlantSpeciesList_Criterion-2008.pdf*).

The factors considered for initial plant selection, as articulated by the SPWG, included the following:

- Is widespread
- Is associated with dominant plant cover type
- Has an important biological influence on other species
- Is readily detectable and has observable phenophases
- Is accessible for schools and in urban areas
- Has pollinator or wind-borne seed dispersal
- Increases diversity of plant functional types
- Increases diversity of temporal responses in phenophases
- Is associated with overstory and understory plants
- Is synchronized with pollinators
- Has responses to changes in fall as well as spring
- Has existing related long-term datasets, including herbarium collections
- Has influence on applied areas of interest such as recreation and tourism (fall foliage), medicine (allergens), agriculture, and natural resources management

The SPWG identified six areas in which phenology information provides societal benefits (see Towards a National Phenology Network (October 2006 *http://usanpn.org/files/shared/towards_a_usa-npn_0.pdf*): 1) scientific research, 2) agriculture, 3) tourism and recreation, 4) human health, 5) natural

resources, and 6) education. The working group agreed that recommended plant species should also contribute toward information in one or more of these areas, in addition to meeting one or more of the factors listed above.

The initial recommendations of the SPWG included 183 plant species. Subsequently the NCO identified the need to broaden the geographic scope of the recommended plant species and the need to add species to accommodate USA-NPN partners who had a focus on the phenology of particular species. In response, 30 plant species were added in 2009 to the initial list.

The recommended species list in 2009 consisted of 23 species that were gymnosperms and 190 angiosperm species. Gymnosperms consisted of two families, with the Pinaceae representing the most species (21). Angiosperms consisted of 165 dicot species and 25 monocot species. Dicots were reprented by 59 families with the most species within Rosaceae (19 species), Fabaceae (18 species), and Asteraceae (17 species). Monocots were represented by 2 families with the most species within Poaceae (15 species.

Calibration species

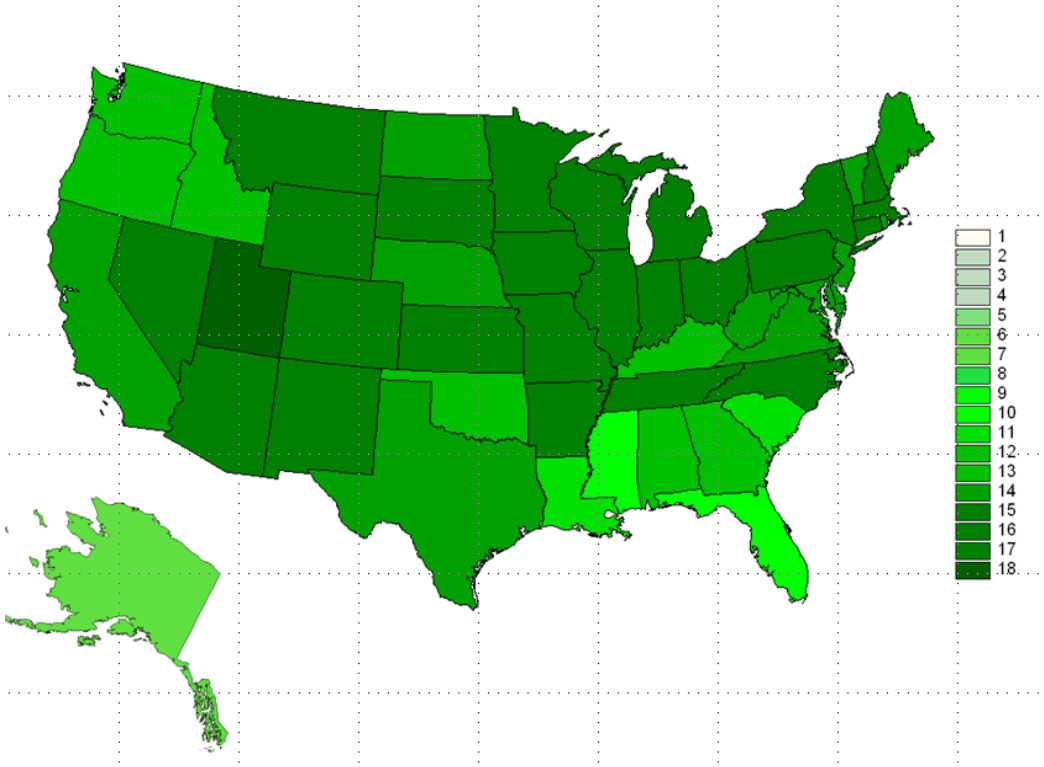
Calibration species were selected so that observations of their phenology will provide adequate data to facilitate the integration of phenology and climate measurements nationally. The relationship determined between phenology and climate for each calibration species can be compared with other species that do not have overlapping distributions within the range of the calibration species. For these reasons, the NCO encourages USA-NPN observers to include at least one calibration species in their monitoring projects.

Together the distributions of the 20 calibration species provide coverage across the entire country with substantial distributional overlap among species (Appendix D). These native and introduced plants have broad distributions and are ecologically or economically important. The number of calibration species per state ranges from 6 to 18; most states have12 or more calibration species (Figure 4).

Cloned Plant Project species

The USA-NPN supports monitoring of cloned plants through the Cloned Plant Project. Cloned plants—i.e., genetically identical plants—respond to climate without the effects of genetic variation among different individuals. An important goal of the USA-NPN is to measure phenology as an indicator of biological responses to climate variation nationally. The value of monitoring genetically identical plants is that we assume differences in their responses to be due to the varying conditions under which they are growing, rather than to genetic variation. The clonally propagated plants have a consistent genotype that facilitates precise measurements of biological responses to climate variation.

Figure 4. The 20 calibration species provide overlapping coverage of all areas of the United States. Each of the continental states has 10 to 18 of the calibration species; Alaska has 7 and Hawaii 6.



The Cloned Plant Project was comprised of three species in 2009: *Syringa* x *chinensis* 'Red Rothomagensis' (cloned Chinese lilac), *Lonicera tatarica* (tartarian honeysuckle), and *Syringa vulgaris*

(the common lilac). Although the common lilac is not a cloned species, it was included as part of the project because its response to climate is quite uniform. The NCO works with the manager of the project, Dr. Mark Schwartz, to make cloned lilacs available each year as funding permits. In addition, the cloned Chinese Lilac is available for independent purchase through Jung's Seed Company (see *http://usanpn.org/?q=lilac-details*).

A historical predecessor of the Cloned Plant Project (the USDA Northeast and North Central Regional Phenology Projects) distributed the tartarian honeysuckle under the name 'Arnold Red honeysuckle'. This species is an invasive plant in much of the United States and phenological networks in the country have not distributed it since 1987. The USA-NPN does not promote further planting or distribution of the species but does accept observations on plants established prior to 1987 as part of the Indicator Observation Program.

The Cloned Plant Project does not yet have national coverage because the range of the cloned Chinese lilac is limited by climate—it is believed to require at least 1375 chilling hours at temperatures below 7.2□C (45□F) (M. Schwartz, pers. comm.). The USA-NPN would like to add additional cloned species suitable for the arid southwest, the maritime west coast and the sub-tropic and temperate south and southeast to ensure nationwide representation by cloned plants. A cloned variety of *Cornus florida* is proposed for the southeast.

Regional species

Regional plant species are native or introduced plants that have a more localized distribution than calibration species, or that are particularly important in certain locales or regions of the nation in terms of ecological processes, biological diversity, conservation, economics, or human culture. The initial list of regional plant species, as identified by the SPWG, was determined using the factors for recommended species, as listed above. The NCO added additional plant species as recommended by regional phenology networks and established phenology monitoring networks that wished to collaborate with the USA-NPN, resulting in 175 regional plant species in 2009.

The regional species list is an area of potential growth for the recommended species list. The target number of recommended species is still undetermined. The NCO wishes to obtain sufficient observations to detect widespread phenology patterns by encouraging observations of recommended species.

Special project species

In 2009, the NCO received requests from organizations and research projects to add 16 plant species that did not necessarily fulfill the criteria for a regional species but were important for a research or special focus study by USA-NPN members. The NCO added plant species known to be nectar sources for the bee species and monarch butterflies reported by participants in the Great Sunflower Project and Monarch Watch. Participants in these organizations monitor an abbreviated set of phenophases for each plant, as noted on each online species profile page for these plants. Other organizations also requested species and genera that are known nectar sources.

On-line implementation

Beginning in 2009, USA-NPN observers were able to register themselves online through the USA-NPN main portal (*http://usanpn.org*) and monitor plant phenology using the phenophase status monitoring approach. There are four steps to get started; although their web presentation has been subsequently modified, the steps remain the same. In 2009, the user was directed from the home page by a blue rectangle button labeled 'Observe!' to the four steps ('Become an observer', Appendix E). Each step was numbered: 1) Learn about the plants to monitor, 2) Get the details on monitoring, 3) Sign up to be an observer, and 4) Log in to MyNPN. Steps 1 or 2 could be done in either order, but step 4 had to follow step 3.

Step one, 'Learn about the plants to monitor', took the observer to a page listing all 213 recommended species and provided a number of search filters, including the ability to search by common name or scientific name ('Search plants to monitor', Appendix F). An online species profile described each of the recommended species with basic information about the plant and the protocols for monitoring the plant (for example '*Corylus americana*', Appendix G).

Step two, 'Get the details on monitoring', directed the user to the 'How to Monitor' page. This page provided the user directions on site and sampling design (Appendix H).

Step three, 'Sign up to be an observer', took the observer to a page that gathered the information needed to register the observer. Once registered, the user was assigned a personal online account for reporting their observations.

Step four: After the observer registered, they proceeded to their online account through the, 'Log in to MyNPN' link. MyNPN consisted of a series of data registration pages used to document the observer's study site and to record all observations. My NPN Home page (Appendix I) displayed the sites and plants registered for a particular user and the documentation the observer provided for the site. The observer added or edited site geographic and environmental information to MyNPN Home using the Register a Site page (Appendix J). The observer added or edited their selected plants using the Add or Edit Plants page (Appendix K). Each individual plant was registered by site and observers could to provide additional information on the growth environment of the plants. We asked the observer to enter their observations for each plant for every visit using the online Observation Data Entry Form (Appendix L). For every phenophase defined for that plant, the observer indicated whether the phenophase was occurring, was not occurring, or they did not check for each visit.

In addition to the four steps to becoming a plant phenology observer, a 'Frequently Asked Questions' section provided more detailed explanation to the on-line observer (Appendix M). Finally Appendix N provides examples of the field datasheets provided to each participant.

Information management

The NPMS relates to the National Phenology Information Management System through a standardization schema and procedures that provide for the addition of observation data to the central data repository, the National Phenology Database. The NCO plans to develop the National Phenology Database such that it can preserve and make accessible phenology observations collected using the phenophase status approach, the phenological event approach, and other approaches historically or currently used for phenology monitoring, including the BBCH scale.

The schema for standardization consists of:

1. Standard definitions for phenophases
2. Standard definitions for phenological events
3. Assignment of appropriate phenophases for each recommended species
4. Definition of the relationship of each phenophase to one or more phenological events
5. Definition of the relationship of each phenological event to the BBCH scale

This standardization schema provides a mechanism for incorporation of most phenology observations into the National Phenology Database. In 2009, the NCO developed initial versions of the first three parts of this schema, as described in Appendix B.

The online data registry tool, MyNPN, is the mechanism for collection of phenology observations. Reported observations are incorporated from the MyNPN registry into the National Phenology Database, with a number of input validation procedures filtering out common site description and data reporting errors.

The National Phenology Database is built on MySQL, a popular relational database framework. The basic data model is groups of tables describing the relationship between a user, site, species, phenophase, and observation record. Each observation record has a specific date descriptor. In 2009, the National Phenology Database consisted of 55 normalized tables. Referential integrity constraints on the tables provide another quality control protecting against erroneous data registration. The National Phenology Database is stored on a secured server with nightly backups.

Results for 2009

In 2009, a total of 2,154 observers registered online and 546 (25.3%), reported observations on 133 plant species. The plant species with the most observers were *Syringa vulgaris, Taraxacum officinale, Forsythia* spp., *Syringa chinensis,* and *Acer rubrum.* All but one of the 20 calibration species were reported by at least one observer. Observers were widespread with at least 49 of the states have reporting observers. Observations reported after March 2nd, when the USA-NPN web site went online,

used the NPMS v0.1 protocols. Observations between January and March 2 of that year used the 2008 beta protocols. Each observation is coded with its respective protocol definition in the NPD.

The NCO conducted a user survey of over 2000 registrants in November 2009. Responses were obtained from 178 registrants, representing both observers and non-observers in 2009. Of both groups over 70% indicated that they joined because they wanted to contribute to a valuable national effort. The majority of observers were over 56 years in age. Most observers planned on participating in the upcoming year (95%). The survey did identify a number of reasons for non-participation in making observations including the registrant making observations but not submitting them online or getting lost in the online registration process or that the plant they wanted to monitor was not on the USA-NPN available list. Results of the user survey will help guide the further development of the program.

Phenology Monitoring: 2010 and beyond

The NCO of the USA-NPN anticipates a number of updates to phenology monitoring in 2010. Prominent among these will be the availability of online monitoring standards and protocols for animals, initially for 58 species.

- Addition of recommended plant species and supporting species profiles; new species may include plants that are representative dominants in ecological systems, species that are important nectar resources, species appropriate for phenology gardens in various ecoregions, and state flowers
- National review of recommended species criteria and refinement of the recommended species list
- Refinement of the NPMS plant phenology monitoring protocols and development of NPMS animal monitoring phenology protocols
- Additional development of the online web presentation (*http:usanpn.org* site)
- Development of visualizations run by web services for the National Phenology Database and for partner organization use using an online interface; visualizations can include maps, graphics, and data summaries
- Development of online tools for database downloads

References Cited

Meier, U. (Ed.). 2001. Growth stages of mono- and dicotyledonous plants. BBCH Monograph, 2. Edition. Federal Biological Research Centre of Agriculture and Forestry. Germany. Available at: *http://www.bba.de/veroeff/bbch/bbcheng.pdf*

Rosenzweig, C., G. Casassa, D.J. Karoly, A. Imeson, C. Liu, A. Menzel, S. Rawlins, T.L. Root, B. Sequin, P. Tryjanowski. 2007: Assessment of observed changes and responses in natural and managed systems. Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Eds.) Cambridge University Press. Cambridge, UK pg. 79-131. Available at: *http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter1.pdf*

Glossary

Phenological event A precisely defined point in the annual life cycle of a plant or animal, generally marking the start or end of a phenophase. The occurrence of a phenological event can be pinpointed to a single date and time (in theory, if not in practice). Examples include the opening of the first flower on a plant, the end of leaf fall on a tree, or the first appearance of a particular songbird species in spring.

Phenophase An observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point. Phenophases generally have duration of a few days or weeks. Examples include the period over which newly emerging leaves are visible, or the period over which open flowers are present on a plant.

Contributions & Acknowledgments

KAT developed the report content. EGD, AJMR, TMC and KAT developed the first version of the monitoring system. EGD developed the initial versions of phenophase definitions and monitoring methods descriptions, as well as the status monitoring concept. AJMR helped develop the status monitoring concept and along with KAT and TMC refined the phenophase definitions and monitoring methods. KAT also compiled the initial recommended species lists. KAT helped shape the structure of the report and reviewed the manuscript.

The USA-National Phenology Network (USA-NPN) National Coordinating Office (NCO) thanks the many people that participated in the implementation meetings of 2005 and 2006 and the Research Coordination Network meeting of 2007 that were the foundation of the USA-NPN. Chief among those organizers were Drs. Mark Schwartz of the University of Wisconsin-Milwaukee and Julio Betancourt of the U.S. Geological Survey. Members of the Species Protocol Working Group contributed to the development of the initial species list, an important step in the implementing the first year of plant phenology monitoring. In addition the work of Mark Losloben, the first assistant director of the NCO, contributed greatly to the implementation of the first USA-NPN website. Development and implementation of NPMS v0.1 was supported by the contributions of: Paul, Alaback, Lisa Benton, Ben Crom, Patty Guertin, Brian Haggerty, Christine Hallman, Art McKee, John O'Keefe, Andrew Richardson, Alyssa Rosemartin, Ramon Vasquez, and Bruce Wilson.

Appendices

Appendix A Species Protocol Working Group Members 2006-2008

2006:

Craig Anderson (Wisconsin Natural Heritage)

Julio Betancourt (U.S. Geological Survey)

David Breshears (University of Arizona)

Kathy Goodin (NatureServe)

Bruce Jones (U.S. Geological Survey)

Michael Loik University of California, Santa Cruz,

Gretchen Meyer (University of Wisconsin-Madison)

Art McKee (Flathead Lake Biological Station, University of Montana)

Bob Szaro (U.S. Geological Survey)

2007:

Stephen Baenziger (University of Nebraska)

Julio Betancourt(U.S. Geological Survey)

Dave Breshears (University of Arizona)

Kjell Bolmgren (University of California, Berkeley),

Ellen Denny (North-East Regional Phenology Network)

Pauline Drobney (U.S. Fish and Wildlife Service)

Abe Miller-Rushing (Rocky Mountain Biological Lab)

Carol Spurrier (Bureau of Land Management)

Robert Szaro (U.S. Geological Survey)

Jack Williams (University of Wisconsin-Madison)

2007:

Julio Betancourt (U.S. Geological Survey)

Ellen Denny (USA-NPN National Coordinating Office)

Mark Losleben (University of Arizona, USA-NPN National Coordinating Office),

Art McKee (Flathead Lake Biological Station, University of Montana)

Abe Miller-Rushing (The Wildlife Society, USA-NPN National Coordinating Office)

Mark Schwartz (University of Wisconsin-Madison)

Kathryn Thomas (U.S. Geological Survey, USA-NPN National Coordinating Office)

Jake Weltzin (U.S. Geological Survey, USA-NPN National Coordinating Office)

2008:

Paul Alaback (University of Montana, Emeritus)

Lisa Benton (University of Arizona, USA-NPN National Coordinating Office)

Ellen Denny (USA-NPN National Coordinating Office)

Brian Haggerty (University of California, Santa Barbara)

Sandra Henderson (National Center for Atmospheric Research)

Abe Miller-Rushing (The Wildlife Society, USA-NPN National Coordinating Office)

Kathryn Thomas (U.S. Geological Survey, USA-NPN National Coordinating Office)

Jake Weltzin (U.S. Geological Survey, USA-NPN National Coordinating Office)

Appendix B 2009 Status monitoring phenophases with corresponding phenological events and BBCH codes

Modifications to the general definitions are listed below each table

B.1 Deciduous Trees and Shrubs (with flowers)

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging leaves	In at least 3 locations on the plant, an emerging leaf is visible. A leaf is considered "emerging" once the green tip is visible at the end of the leaf bud, but before it has fully unfolded to expose the petiole (leaf stalk) or leaf base.	Start	Leaf budburst	9
		End	All leaves unfolded	19
Unfolded leaves	In at least 3 locations on the plant, an unfolded leaf is visible. A leaf is considered "unfolded" when the petiole (leaf stalk) or leaf base is visible. The leaf may need to be bent backwards to see whether the petiole or leaf base is visible.	Start	First leaf	11
≥75% of full leaf size	For the whole plant, the majority of leaves are unfolded and have elongated to at least three-quarters (75%) of their mature size. Leaf size may also be estimated by viewing the canopy as a whole. At 75% of full leaf size, the canopy appears to be approximately three-quarters (75%) full.	Start	75% of full leaf size	47
≥50% of leaves colored	For the whole plant, at least half (50%) of the leaves (including any that have fallen to the ground) have changed to their late-season colors.	Start	50% of leaves colored	92c

All leaves colored	For the whole plant, virtually all (95-100%) of the leaves (including any that have fallen to the ground) have changed to their late-season colors, and there is virtually no green left in the leaves.	Start	All leaves colored	92e
≥50% of leaves fallen	For the whole plant, at least half (50%) of the leaves have fallen.	Start	50% of leaves fallen	95
All leaves fallen	For the whole plant, virtually all (95-100%) of the leaves have fallen.	Start	All leaves fallen	97
Flowers				
Open flowers	In at least 3 locations on the plant, an open fresh flower is visible. Flowers are considered "open" when the reproductive parts are visible between unfolded or open flower parts. Do not include spent (wilted) flowers that remain on the plant.	Start	First flowers	60
		End	End of flowering	69
Full flowering	For the whole plant, at least half (50%) of the flowers are open and still fresh.	Start	Full flower or Peak flower	65
Fruits				
Ripe fruits	In at least 3 locations on the plant, a ripe fruit is visible. (For a more specific description of this phenophase, please check the plant species profile online.). *Species definitions for fruit phenophases are still in progress.*	Start	First fruit ripe	89

Modification 1: For *Forsythia* spp. the phenophase protocols were modified such that the "≥ 75% of full leave size" and "Ripe fruits" phenophases were excluded.
Modification 2: For *Fouquieria splendens* the phenophase protocols were modified such that only "Unfolded leaves", "Open flowers" and "Full flowering" are included.

B.2 Deciduous Trees and Shrubs (with catkins)

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Same as A.1 with the following replacing flower phenophases				
Pollen release	In at least 3 locations on the plant, pollen is released from an inflorescence when gently shaken or blown.	Start	First pollen released	60
		End	End of pollen release	69
Full pollen release	For the whole plant, at least half (50%) of the inflorescences release pollen when gently shaken or blown.	Start	Full pollen or Peak pollen	65

B.3 Broadleaf Evergreen Trees and Shrubs

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging leaves	In at least 3 locations on the plant, an emerging leaf is visible. A leaf is considered "emerging" once the green tip is visible at the end of the leaf bud, but before it has fully unfolded to expose the petiole (leaf stalk) or leaf base.	Start	Leaf budburst	9
		End	All leaves unfolded	19
Young unfolded leaves	In at least 3 locations on the plant, a young unfolded leaf is visible. A leaf is considered "young" and "unfolded" once the leaf stalk (petiole) or leaf base is visible, but before the leaf has reached full size or turned the darker green color of mature leaves on the plant. The leaf may need to be bent backwards to see whether the petiole or leaf base is visible.	Start	First leaf	11
Flowers				
Open flowers	In at least 3 locations on the plant, an open fresh flower is visible. Flowers are considered "open" when the reproductive parts are visible between unfolded or open flower parts. Do not include spent (wilted) flowers that remain on the plant.	Start	First flowers	60
		End	End of flowering	69
Full flowering	For the whole plant, at least half (50%) of the flowers are open and still fresh.	Start	Full flower or Peak flower	65
Fruits				
Ripe fruits	In at least 3 locations on the plant, a ripe fruit is visible. (For a more specific description of this phenophase, please check the plant species profile online.). *Species definitions for fruit phenophases are still in progress.*	Start	First fruit ripe	89

Modification 1: For all *Arctostaphylos uva-ursi*, *Cornus canadensis*, *Dryas octopetala*, and *Linnea borealis,* all phenophases except "Open flowers" had the phrase 'In at least 3 locations." edited to "In at least one location…"
Modification 2: For *Larrea tridentata*, all phenophases except "Open flowers" had the phrase 'In at least 3 locations." edited to "In at least one location…" and the phenophase "Full flowering" was deleted.
Modification 3: For *Ficus citrifolia* the phenophases "Open flowers" and "Full flowering" are deleted.

B.4 Conifers

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Needles				
Emerging needles	In at least 3 locations on the plant, an emerging needle is visible. A needle is considered "emerging" once the green tip is visible at the end of the bud, but before the needle has unfolded and spread away from the developing stem.	Start	Needle budburst	9
		End	All leaves unfolded	19
Young unfolded needles	In at least 3 locations on the plant, a young unfolded needle is visible. A needle is considered "young" and "unfolded" once it has spread away from the developing stem enough that its point of attachment to the stem is visible, but before it has reached full size and turned the darker green color of mature needles on the plant.	Start	First needle	11
Pollen cones				
Pollen release	In at least 3 locations on the plant, pollen is released from a male cone when it is gently shaken or blown.	Start	First pollen released	60
		End	End of pollen release	69
Full pollen release	For the whole plant, at least half (50%) of the male cones release pollen when gently shaken or blown.	Start	Full pollen or Peak pollen	65
Seed cones				
Ripe seed cones	In at least 3 locations on the plant, a ripe seed cone is visible. (For a more specific description of this phenophase, please check the plant species profile online.). *Species definitions for seed cone phenophases are still in progress.*	Start	First cone ripe	89

Modification 1: For all multi-needle *Pinus* species the phenophase protocols were modified such that: “Emerging needles” definition reads **“**In at least 3 locations on the plant, an emerging needle or needle bundle is visible. A needle or needle bundle is considered "emerging" once the green tip is visible along the newly developing stem

(candle), but before the needles have begun to unfold and spread away from others in the bundle. “Young unfolded needles” definition reads “In at least 3 locations on the plant, a young unfolded needle is visible. A needle is considered "young" and "unfolded" once it begins to spread away from other needles in the bundle (and is no longer pressed flat against them), but before it has reached full size and turned the darker green color of mature needles on the plant.”

Modification 2: For all *Juniperus* species, the phenophase protocols were modified such that: “Emerging needles” and “Young unfolded needles” phenophases are deleted.

Modification 3: For *Larix laricina*, the phenophase protocols were modified such that: “Young unfolded needles” is replaced by “ Unfolded needles” which reads “In at least 3 locations on the plant, an unfolded needle is visible. A needle is considered “unfolded” once it begins to spread away from other needles in the bundle and is no longer pressed flat against them.” Additional phenophases are “≥50% of needles colored” which reads “For the whole plant, at least half (50%) of the needles (including any that have fallen to the ground) have changed to their late-season colors”; “All needles colored” which reads “For the whole plant, virtually all (95-100%) of the needles (including any that have fallen to the ground) have changed to their late-season colors, and there is virtually no green left in the needles”; **“**≥50% of needles fallen” which reads “For the whole plant, at least half (50%) of the needles have fallen”; “All needles fallen” which reads “For the whole plant, virtually all (95-100%) of the needles have fallen.

B.5 Herbs

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging growth	New bright green growth of the plant is visible above the soil surface, either from aboveground buds with green tips, or new green or white shoots breaking through the soil surface. Growth is considered "emerging" until the first leaf has fully unfolded from that bud or shoot.	Start	Emergence above ground	9
Unfolded leaves	In at least one location on the plant, a fully unfolded leaf is visible. For seedlings, consider only true leaves and do not count the cotyledons (one or two small, round leaves) that are found on the stem almost immediately after the seedling emerges.	Start	First leaf	11
All leaves withered	Of the leaves that developed this season, virtually all (95-100%) are dried and dead.	Start	All leaves senesced	97
Flowers				
Open flowers	In at least one location on the plant, an open fresh flower is visible. Flowers are considered "open" when the reproductive parts are visible between unfolded or open flower parts. Do not include spent (wilted) flowers that remain on the plant.	Start	First flowers	60
		End	End of flowering	69
Fruits				
Ripe fruits	In at least one location on the plant, a ripe fruit is visible. (For a more specific description of this phenophase, please check the plant species profile online.). *Species definitions for fruit phenophases are still in progress.*	Start	First fruit ripe	89

Modification 1: For *Arisaema triphyllum* the "Open flowers" phenophase was excluded.

B.6 Grasses

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging growth	New growth of the plant is visible above the soil surface with the appearance of fresh green shoots that show no signs of aging. For each shoot, growth is considered "emerging" until the first leaf has unfolded.	Start	Emergence above ground	9
Unfolded leaves	In at least one location on the plant, an unfolded leaf is visible. A leaf is considered "unfolded" when it unrolls slightly from around the stem and begins to fall away at an angle.	Start	First leaf	11
All leaves withered	Of the leaves that developed this season, virtually all (95-100%) are dried and dead.	Start	All leaves senesced	97
Flowers				
Open flowers	In at least one location on the plant, an open fresh flower is visible. Flowers are considered "open" when the reproductive parts are visible between unfolded or open flower parts. Do not include dried flower parts that remain on the plant.	Start	First flowers	60
		End	End of flowering	69
Fruits				
Ripe seeds	In at least one location on the plant, a ripe seed is present. A ripe seed is hard when squeezed and is difficult to divide with a fingernail. Seeds may also be considered ripe when they fall into your hand when the plant is handled.	Start	First fruit ripe	89

B.7 Cacti

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Flowers				
Flower buds	In at least one location on the plant, a flower bud or unopened flower is visible. A flower is considered "unopened" up until the point when reproductive parts are visible between unfolded or open flower parts.			
Open flowers	In at least one location on the plant, an open fresh flower is visible. Flowers are considered "open" when the reproductive parts are visible between unfolded or open flower parts. Do not include spent (wilted) flowers that remain on the plant.	Start	First flowers	60
		End	End of flowering	69
Fruits				
Ripe fruits	In at least one location on the plant, a ripe fruit is visible. (For a more specific description of this phenophase, please check the plant species profile online.). *Species definitions for fruit phenophases are still in progress.*	Start	First fruit ripe	89

B.8 Cloned lilac

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging leaves (formerly "First leaf"*)	In at least 3 locations on the plant, an emerging leaf is visible. A leaf is considered "emerging" once the widest part of the newly emerging leaf has grown beyond the ends of its opening winter bud scales, but before it has fully emerged to expose the petiole (leaf stalk) or leaf base. The leaf is distinguished by its prominent midrib and veins.	Start	Leaf budburst	9
		End	All leaves unfolded	19
All leaves emerged (formerly "Full leaf out")	For the whole plant, the widest part of a new leaf has emerged from virtually all (95-100%) of the actively growing leaf buds.	TBD	TBD	TBD
Flowers				
Open flowers (formerly "First bloom")	For the whole plant, at least half (50%) of the flower clusters have at least one open fresh flower. The lilac flower cluster is a grouping of many, small individual flowers.	TBD	TBD	TBD
		TBD	TBD	TBD
Full flowering (Formerly "Full bloom")	For the whole plant, virtually all (95-100%) of the flower clusters no longer have any unopened flowers, but many of the flowers are still fresh and have not withered.	TBD	TBD	TBD
End of flowering (formerly "Last Bloom")	For the whole plant, virtually all (95-100%) of the flower clusters no longer have any unopened flowers, but many of the flowers are still fresh and have not withered.	TBD	TBD	TBD

* Previous to 2009, the phenophases for the cloned lilac were known by the titles indicated in parenthesis.

B.9 Cloned honeysuckle

Phenophase	Phenophase Definition	Phenophase/ phenological event relationship	Phenological Event	BBCH code
Leaves				
Emerging leaves	In at least 3 locations on the plant, an emerging leaf is visible. A leaf is considered "emerging" once the widest part of the newly emerging leaf has grown beyond the ends of its opening winter bud scales, but before it has fully emerged to expose the petiole (leaf stalk) or leaf base. The leaf is distinguished by its prominent midrib and veins.	Start	Leaf budburst	9
		End	All leaves unfolded	19
All leaves emerged	For the whole plant, the widest part of a new leaf has emerged from virtually all (95-100%) of the actively growing leaf buds.	TBD	TBD	TBD
Flowers				
Open flowers	For the whole plant, at least 5% of the flowers are open and still fresh.	TBD	TBD	TBD
		TBD	TBD	TBD
Full flowering	For the whole plant, virtually all (95-100%) of the flowers have opened, and many of the flowers are still fresh and have not withered.	TBD	TBD	TBD
End of flowering	For the whole plant, virtually all (95-100%) of the flowers have withered or dried up and the floral display has ended.	TBD	TBD	TBD

Appendix C Recommended plant species 2009

Genus	Species	Common_Name	ITIS	Type	Protocol[5]
Abies	*balsamea*	balsam fir	18032	Calibration	B.4
Abies	*concolor*	white fir	181826	Regional	B.4
Abies	*grandis*	grand fir	183284	Regional	B.4
Abies	*lasiocarpa*	subalpine fir	181830	Regional	B.4
Acacia	*koa*	koa	182079	Regional	B.3
Acer	*glabrum*	Rocky Mountain maple	28742	Regional	B.1
Acer	*macrophyllum*	bigleaf maple	28748	Regional	B.1
Acer	*negundo*	boxelder	28749	Regional	B.1
Acer	*pensylvanicum*	striped maple	28754	Regional	B.1
Acer	*rubrum*	red maple	28728	Regional	B.1
Acer	*saccharum*	sugar maple	28731	Regional	B.1
Achillea	*millefolium*	common yarrow	35423	Regional	B.5
Alnus	*incana*	gray alder	19471	Regional	B.2
Alnus	*rubra*	red alder	19474	Regional	B.2
Ambrosia	*artemisiifolia*	annual ragweed	36496	Calibration	B.5
Ambrosia	*psilostachya*	cuman ragweed	36516	Calibration	B.5
Amelanchier	*alnifolia*	Saskatoon serviceberry	25109	Regional	B.1
Amelanchier	*canadensis*	Canadian serviceberry	25112	Regional	B.1
Amelanchier	*utahensis*	Utah serviceberry	25121	Regional	B.1
Andropogon	*gerardii*	big bluestem	40462	Calibration	B.6
Aquilegia	*caerulea*	Colorado blue columbine	565004	Regional	B.5
Aquilegia	*canadensis*	red columbine	18730	Regional	B.5
Aquilegia	*formosa*	western columbine	18738	Regional	B.5
Arctostaphylos	*uva-ursi*	kinnikinnick	23530	Regional	B.3/Mod. 1
Arisaema	*triphyllum*	jack in the pulpit	42525	Regional	B.5/Mod. 1
Artemisia	*tridentata*	big sagebrush	35498	Regional	B.3
Asclepias	*asperula*	spider milkweed	30247	Regional	B.5
Asclepias	*incarnata*	swamp milkweed	30241	Special	B.5
Asclepias	*speciosa*	showy milkweed	30304	Regional	B.5
Asclepias	*sullivanti*	prairie milkweed	30309	Special	B.5
Asclepias	*syriaca*	common milkweed	30310	Special	B.5
Asclepias	*tuberosa*	butterfly milkweed	30313	Special	B.5
Asclepias	*viridis*	green antelopehorn	30323	Special	B.5
Avicennia	*germinans*	black mangrove	32137	Regional	B.3
Berlandiera	*pumila*	soft greeneyes	36833	Regional	B.5
Betula	*alleghaniensis*	yellow birch	19481	Regional	B.2
Betula	*lenta*	sweet birch	19487	Regional	B.2
Betula	*papyrifera*	paper birch	19489	Regional	B.2
Bouteloua	*curtipendula*	sideoats grama	41500	Regional	B.6
Bouteloua	*gracilis*	blue grama	41493	Calibration	B.6
Brassica	*rapa*	field mustard	23063	Regional	B.5
Brassica	*tournefortii*	Asian mustard	23064	Regional	B.5
Bromus	*rubens*	red brome	40518	Regional	B.6
Bromus	*tectorum*	cheatgrass	40524	Regional	B.6
Buchloe	*dactyloides*	buffalograss	41533	Regional	B.6

Genus	Species	Common_Name	ITIS	Type	Protocol[5]
Bursera	*simaruba*	gumbo limbo	28766	Regional	B.3
Caltha	*palustris*	yellow marsh marigold	18454	Regional	B.5
Carnegia	*gigantea*	saguaro	501299	Regional	B.7
Carya	*glabra*	pignut hickory	19231	Regional	B.2
Carya	*ovata*	shagbark hickory	19242	Regional	B.2
Ceanothus	*velutinus*	snowbrush ceanothus	28517	Regional	B.3
Centaurea	*biebersteinii*	spotted knapweed	501347	Calibration	B.5
Centaurea	*solstitialis*	yellow star-thistle	36972	Regional	B.5
Cephalanthus	*occidentalis*	common buttonbush	34786	Special	B.1
Cercis	*canadensis*	eastern redbud	25782	Regional	B.1
Cercocarpus	*ledifolius*	curl-leaf mountain mahogany	25134	Regional	B.3
Cheirodendron	*trigynum*	olapalapa	29385	Regional	B.3
Cirsium	*arvense*	Canada thistle	36335	Calibration	B.5
Citrus	*spp.*	citrus	28882	Regional	B.3
Claytonia	*lanceolata*	lanceleaf springbeauty	20390	Regional	B.5
Claytonia	*virginica*	Virginia springbeauty	20382	Regional	B.5
Clintonia	*borealis*	bluebead	42903	Regional	B.5
Coccoloba	*microstachya*	puckhout	21042	Regional	B.3
Conocarpus	*erectus*	button mangrove	27766	Regional	B.3
Cornus	*canadensis*	bunchberry dogwood	27816	Regional	B.3/Mod. 1
Cornus	*florida*	flowering dogwood	27806	Regional	B.1
Cornus	*nuttallii*	Pacific dogwood	27809	Regional	B.1
Cornus	*sericea*	redosier dogwood	501637	Regional	B.1
Corylus	*americana*	American hazelnut	19506	Regional	B.2
Corylus	*cornuta*	beaked hazelnut	19507	Regional	B.2
Dasiphora	*floribunda*	shrubby cinquefoil	565123	Regional	B.1
Deschampsia	*cespitosa*	tufted hairgrass	502001	Regional	B.6
Dodecatheon	*meadia*	pride of Ohio	23969	Regional	B.5
Dodecatheon	*pulchellum*	darkthroat shooting star	23945	Regional	B.5
Dodonaea	*viscosa*	Florida hopbush	28675	Regional	B.3
Dryas	*octopetala*	eightpetal mountain-avens	24619	Regional	B.3/Mod. 1
Echinacea	*purpurea*	eastern purple coneflower	37281	Special	B.5
Erythronium	*albidum*	white fawnlily	42927	Regional	B.5
Erythronium	*americanum*	dogtooth violet	196365	Regional	B.5
Eschscholzia	*californica*	California poppy	18956	Regional	B.5
Euphorbia	*esula*	leafy spurge	28064	Regional	B.5
Fagus	*grandifolia*	American beech	19462	Regional	B.1
Ficus	*citrifolia*	wild banyantree	19094	Regional	B.3/Mod. 3
Forsythia	*spp.*	forsythia	32961	Calibration	B.1/Mod. 1
Fouquieria	*splendens*	ocotillo	502645	Regional	B.1/Mod. 2
Fragaria	*virginiana*	Virginia strawberry	24639	Calibration	B.5
Fraxinus	*americana*	white ash	32931	Regional	B.1
Fraxinus	*pennsylvanica*	green ash	32929	Regional	B.1
Glycine	*max*	soybean	26716	Regional	B.5
Gossypium	*barbadense*	creole cotton	21710	Regional	B.5
Gossypium	*hirsutum*	upland cotton	21711	Regional	B.5
Guaiacum	*sanctum*	holywood	29041	Regional	B.3
Gymnanthes	*lucida*	oysterwood	502845	Regional	B.3
Hamamelis	*virginiana*	American witchhazel	19033	Regional	B.1

Genus	Species	Common_Name	ITIS	Type	Protocol[5]
Helianthus	*annuus*	common sunflower	36616	Special	B.5
Heracleum	*maximum*	common cowparsnip	502953	Regional	B.5
Hesperostipa	*comata*	needle and thread	507974	Regional	B.6
Ilex	*anomala*	Hawaii holly	28014	Regional	B.3
Impatiens	*capensis*	jewelweed	29182	Regional	B.5
Ipomopsis	*aggregata*	scarlet gilia	31192	Regional	B.5
Juglans	*nigra*	black walnut	19254	Regional	B.1
Juniperus	*ashei*	Ashe's juniper	194812	Regional	B.4/Mod. 2
Juniperus	*virginiana*	eastern redcedar	18048	Calibration	B.4/Mod. 2
Laguncularia	*racemosa*	white mangrove	503318	Regional	B.3
Larix	*laricina*	tamarack	183412	Regional	B.4/Mod. 3
Larrea	*tridentata*	creosote bush	29051	Regional	B.3/Mod. 2
Lespedeza	*cuneata*	sericia lespedeza	25898	Regional	B.5
Leucaena	*leucocephala*	white leadtree	26766	Regional	B.3
Lewisia	*rediviva*	bitter root	20490	Regional	B.5
Liatris	*aspera*	tall blazing star	37909	Special	B.5
Linnaea	*borealis*	twinflower	35314	Regional	B.3/Mod. 1
Liquidambar	*styraciflua*	sweetgum	19027	Regional	B.1
Liriodendron	*tulipifera*	tuliptree	18086	Regional	B.1
Lonicera	*tatarica*	Tatarian honeysuckle	35306	Cloned	B.9
Lupinus	*perennis*	sundial lupine	26091	Regional	B.5
Lupinus	*polyphyllus*	bigleaf lupine	25921	Regional	B.5
Lythrum	*salicaria*	purple loosestrife	27079	Regional	B.5
Mahonia	*repens*	creeping barberry	195045	Regional	B.3
Maianthemum	*canadense*	Canada mayflower	503653	Regional	B.5
Malus	*pumila*	paradise apple	25262	Calibration	B.1
Medicago	*sativa*	alfalfa	183623	Calibration	B.5
Melilotus	*officinalis*	yellow sweetclover	26150	Regional	B.5
Mertensia	*virginica*	Virginia bluebells	31673	Regional	B.5
Metrosideros	*polymorpha*	'ohi'a lehua	27259	Regional	B.3
Myoporum	*sandwicense*	naio	34079	Regional	B.1
Myriophyllum	*spicatum*	Eurasian watermilfoil	27039	Regional	B.5
Myrsine	*lessertiana*	kolea lau nui	23916	Regional	B.3
Oenothera	*biennis*	common evening primrose	27368	Regional	B.5
Oenothera	*caespitosa*	tufted evening primrose	565328	Regional	B.5
Oenothera	*speciosa*	pinkladies	27415	Regional	B.5
Oligoneuron	*rigidum*	stiff goldenrod	508151	Special	B.5
Olneya	*tesota*	desert ironwood	26808	Regional	B.3
Oxalis	*montana*	mountain woodsorrel	29090	Regional	B.5
Panicum	*virgatum*	switchgrass	40913	Calibration	B.6
Parkinsonia	*florida*	blue paloverde	26827	Regional	B.3
Parkinsonia	*microphylla*	yellow paloverde	26828	Regional	B.3
Pascopyrum	*smithii*	western wheatgrass	504124	Calibration	B.6
Passiflora	*incarnata*	purple passionflower	504139	Regional	B.5
Pennisetum	*ciliare*	buffelgrass	504198	Regional	B.6
Persea	*americana*	avocado	18154	Regional	B.3
Phacelia	*hastata*	silverleaf phacelia	31529	Regional	B.5
Philadelphus	*lewisii*	Lewis' mock orange	24430	Regional	B.1
Phragmites	*australis*	common reed	41072	Regional	B.6

Genus	Species	Common_Name	ITIS	Type	Protocol[5]
Picea	*engelmannii*	Engelmann spruce	183291	Regional	B.4
Picea	*glauca*	white spruce	183295	Regional	B.4
Picea	*mariana*	black spruce	183302	Regional	B.4
Picea	*rubens*	red spruce	18034	Regional	B.4
Pilosocereus	*royenii*	Royen's tree cactus	504399	Regional	B.7
Pinus	*edulis*	twoneedle pinyon	183336	Calibration	B.4/Mod. 1
Pinus	*flexilis*	limber pine	183343	Regional	B.4/Mod. 1
Pinus	*longaeva*	Great Basin bristlecone pine	183352	Regional	B.4/Mod. 1
Pinus	*monophylla*	singleleaf pinyon	183353	Regional	B.4
Pinus	*palustris*	longleaf pine	18038	Regional	B.4/Mod. 1
Pinus	*ponderosa*	ponderosa pine	183365	Calibration	B.4/Mod. 1
Pinus	*strobus*	eastern white pine	183385	Regional	B.4/Mod. 1
Pinus	*taeda*	loblolly pine	18037	Regional	B.4/Mod. 1
Pisonia	*albida*	corcho bobo	19609	Regional	B.1
Podophyllum	*peltatum*	mayapple	18850	Regional	B.5
Polygonum	*cuspidatum*	Japanese knotweed	20889	Regional	B.5
Populus	*tremuloides*	quaking aspen	195773	Calibration	B.1
Prosopis	*glandulosa*	honey mesquite	26879	Regional	B.3
Prosopis	*juliflora*	mesquite	565434	Regional	B.3
Prunus	*americana*	American plum	24763	Special	B.1
Prunus	*dulcis*	sweet almond	24775	Regional	B.1
Prunus	*emarginata*	bitter cherry	24776	Regional	B.1
Prunus	*persica*	peach	24765	Regional	B.1
Prunus	*serotina*	black cherry	24764	Regional	B.1
Prunus	*serrulata*	Japanese flowering cherry	506233	Special	B.1
Prunus	*virginiana*	chokecherry	24806	Calibration	B.1
Prunus	*yedoensis*	Yoshino cherry	No Data	Special	B.1
Pseudoroegneria	*spicata*	bluebunch wheatgrass	504637	Regional	B.6
Pseudotsuga	*menziesii*	Douglas-fir	183424	Regional	B.4
Pueraria	*montana*	kudzu	504683	Regional	B.1
Pulsatilla	*patens*	eastern pasqueflower	18799	Regional	B.5
Purshia	*tridentata*	antelope bitterbrush	25290	Regional	B.3
Quercus	*alba*	white oak	19290	Regional	B.2
Quercus	*macrocarpa*	bur oak	19287	Regional	B.2
Quercus	*rubra*	northern red oak	19408	Regional	B.2
Rhamnus	*cathartica*	common buckthorn	28573	Regional	B.1
Rhizophora	*mangle*	red mangrove	27791	Regional	B.3
Robinia	*pseudoacacia*	black locust	504804	Regional	B.1
Rosa	*woodsii*	Woods's rose	24847	Regional	B.1
Salix	*glauca*	greyleaf willow	22482	Regional	B.1
Sambucus	*nigra*	black elderberry	35324	Regional	B.1
Solidago	*missouriensis*	Missouri goldenrod	36277	Regional	B.5
Sophora	*chrysophylla*	mamani	505293	Regional	B.3
Sorbus	*americana*	American mountain ash	25319	Regional	B.1
Sphaeralcea	*coccinea*	scarlet globemallow	21920	Regional	B.5
Spigelia	*marilandica*	woodland pinkroot	505330	Regional	B.5
Symphoricarpos	*albus*	common snowberry	35332	Regional	B.1
Symphyotrichum	*ericoides*	white heath aster	522202	Special	B.5
Syringa	*chinensis*	Red Rothomagensis lilac	No data	Cloned	B.8

Genus	Species	Common_Name	ITIS	Type	Protocol[5]
Syringa	*vulgaris*	common lilac	32996	Calibration	B.8
Tabebuia	*heterophylla*	white cedar	34345	Regional	B.3
Tamarix	spp.	tamarisk	22303	Regional	B.3
Taraxacum	*officinale*	common dandelion	36213	Calibration	B.5
Tilia	*americana*	American basswood	21536	Regional	B.1
Tradescantia	*ohiensis*	bluejacket	39169	Regional	B.5
Trifolium	*repens*	white clover	26206	Regional	B.5
Trillium	*erectum*	red trillium	43070	Regional	B.5
Trillium	*grandiflorum*	white trillium	43074	Regional	B.5
Trillium	*ovatum*	Pacific trillium	43080	Regional	B.5
Trillium	*undulatum*	painted trillium	43092	Regional	B.5
Triticum	spp.	wheat	42236	Regional	B.6
Tsuga	*canadensis*	eastern hemlock	183397	Regional	B.4
Tsuga	*heterophylla*	western hemlock	183400	Regional	B.4
Tsuga	*mertensiana*	mountain hemlock	183402	Regional	B.4
Urochloa	*maxima*	guineagrass	507480	Regional	B.6
Vaccinium	*corymbosum*	highbush blueberry	23573	Regional	B.1
Verbesina	*virginica*	white crownbeard	38613	Special	B.5
Vernonia	*fasciculata*	prairie ironweed	38629	Special	B.5
Viburnum	*lantanoides*	hobblebush	35265	Regional	B.1
Vitis	*vinifera*	wine grape	28629	Regional	B.1

[5] Protocol code refers to the coding used in Appendix B for the protocol group and any modifications to that protocol group.

Appendix D States represented by calibration species

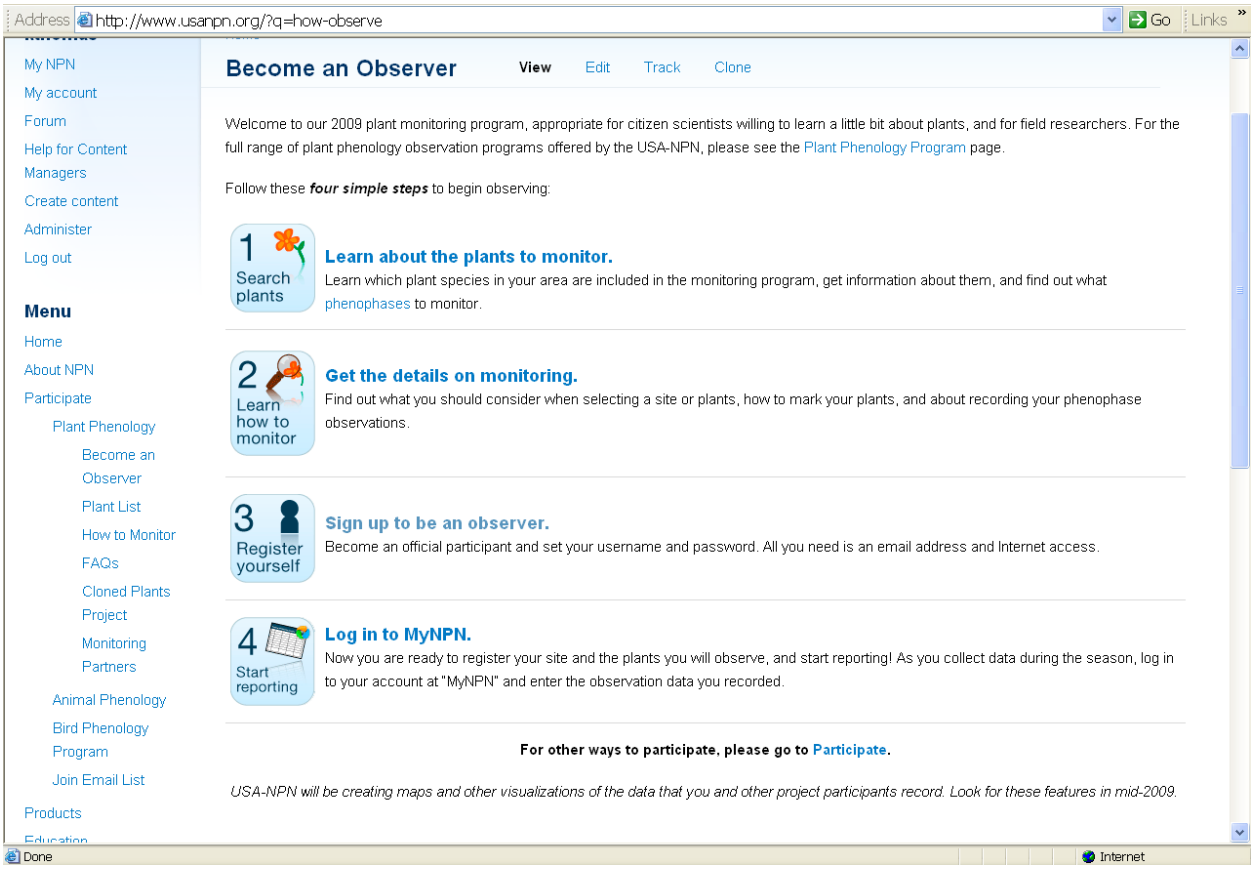
State	*Acer rubrum*	*Ambrosia artemisiifolia*	*Ambrosia psilostachya*	*Andropogon gerardii*	*Bouteloua gracilis*	*Centaurea biebersteinii*	*Cirsium arvense*	*Forsythia* spp.	*Fragaria virginiana*	*Juniperus virginiana*	*Malus pumila*	*Medicago sativa*	*Panicum virgatum*	*Pascopyrum smithii*	*Pinus edulis*	*Pinus ponderosa*	*Populus tremuloides*	*Prunus virginiana*	*Syringa vulgaris*	*Tara1acum officinale*	Number of calibration plants in state
Alaska							X		X			X		X			X	X		X	7
Alabama	X	X	X	X		X	X	X	X	X	X	X	X							X	13
Arkansas	X	X	X	X		X	X	X	X	X	X	X	X	X			X	X	X	X	17
Arizona		X	X	X	X	X	X		X			X	X	X	X	X	X	X		X	15
California		X	X		X	X	X		X		X	X		X	X	X	X	X		X	14
Colorado		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	18
Connecticut	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	17
District of Columbia	X	X		X			X		X	X	X	X	X					X	X	X	12
Delaware	X	X		X		X	X		X	X	X	X	X				X	X		X	13
Florida	X	X	X	X	X	X			X	X		X	X							X	11
Georgia	X	X	X	X		X			X	X	X	X	X	X				X		X	13
Hawaii		X				X			X			X	X							X	6
Iowa	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X	17
Idaho			X		X	X	X		X			X	X	X		X	X	X		X	12
Illinois	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	18
Indiana	X	X	X	X		X	X	X	X	X	X	X	X	X			X	X		X	16
Kansas		X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	16
Kentucky	X	X		X		X	X		X	X	X	X	X	X				X	X	X	14
Louisiana	X	X	X	X		X		X	X	X	X	X	X							X	12
Massachusetts	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	18
Maryland	X			X		X	X	X	X	X	X	X	X				X	X	X	X	14

State	*Acer rubrum*	*Ambrosia artemisiifolia*	*Ambrosia psilostachya*	*Andropogon gerardii*	*Bouteloua gracilis*	*Centaurea biebersteinii*	*Cirsium arvense*	*Forsythia* spp.	*Fragaria virginiana*	*Juniperus virginiana*	*Malus pumila*	*Medicago sativa*	*Panicum virgatum*	*Pascopyrum smithii*	*Pinus edulis*	*Pinus ponderosa*	*Populus tremuloides*	*Prunus virginiana*	*Syringa vulgaris*	*Tara1acum officinale*	Number of calibration plants in state
Maine	X	X	X	X	X	X	X		X	X	X	X	X				X	X	X	X	16
Michigan	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X	17
Minnesota	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X	17
Missouri	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X	17
Mississippi	X	X	X	X					X	X	X	X	X							X	10
Montana		X	X	X	X	X	X	X	X		X	X	X	X		X	X	X		X	16
North Carolina	X	X	X	X		X	X	X	X	X	X	X	X				X	X	X	X	16
North Dakota			X	X	X		X		X	X		X	X	X		X	X	X		X	13
Nebraska		X	X	X	X	X	X		X	X		X	X	X		X	X	X		X	15
New Hampshire	X	X	X	X		X	X	X	X	X	X	X	X	X			X	X	X	X	17
New Jersey	X	X		X		X	X	X	X	X	X	X	X				X	X	X	X	15
New Me1ico		X	X	X		X	X		X		X	X	X	X	X	X	X	X		X	15
Nevada		X	X		X	X	X		X		X	X	X	X	X	X	X	X		X	15
New York	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	18
Ohio	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	18
Oklahoma	X	X	X	X	X				X	X		X	X	X	X	X		X		X	14
Oregon		X	X			X	X		X	X	X	X		X		X	X	X	X	X	14
Pennsylvania	X	X	X	X		X	X	X	X	X	X	X	X				X	X	X	X	16
Rhode Island	X	X		X		X	X	X	X	X	X	X	X				X	X	X	X	15
South Carolina	X	X	X	X	X	X			X	X	X	X	X							X	12
South Dakota		X	X	X	X	X	X		X	X		X	X	X		X	X	X	X	X	16
Tennessee	X	X	X	X		X	X	X	X	X	X	X	X	X				X	X	X	16
Te1as	X	X	X	X	X				X	X		X	X	X	X	X	X	X		X	15
Utah		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	18
Virginia	X			X		X	X	X	X	X		X	X				X	X	X	X	13
Vermont	X	X	X	X		X	X		X	X	X	X	X				X	X	X	X	15

State	*Acer rubrum*	*Ambrosia artemisiifolia*	*Ambrosia psilostachya*	*Andropogon gerardii*	*Bouteloua gracilis*	*Centaurea biebersteinii*	*Cirsium arvense*	*Forsythia* spp.	*Fragaria virginiana*	*Juniperus virginiana*	*Malus pumila*	*Medicago sativa*	*Panicum virgatum*	*Pascopyrum smithii*	*Pinus edulis*	*Pinus ponderosa*	*Populus tremuloides*	*Prunus virginiana*	*Syringa vulgaris*	*Tara1acum officinale*	Number of calibration plants in state
Washington		X	X			X	X	X	X		X	X		X		X	X	X		X	13
Wisconsin	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X	17
West Virginia	X	X		X		X	X	X	X	X	X	X	X				X	X	X	X	15
Wyoming		X	X	X	X	X	X		X		X	X	X	X	X	X	X	X		X	16

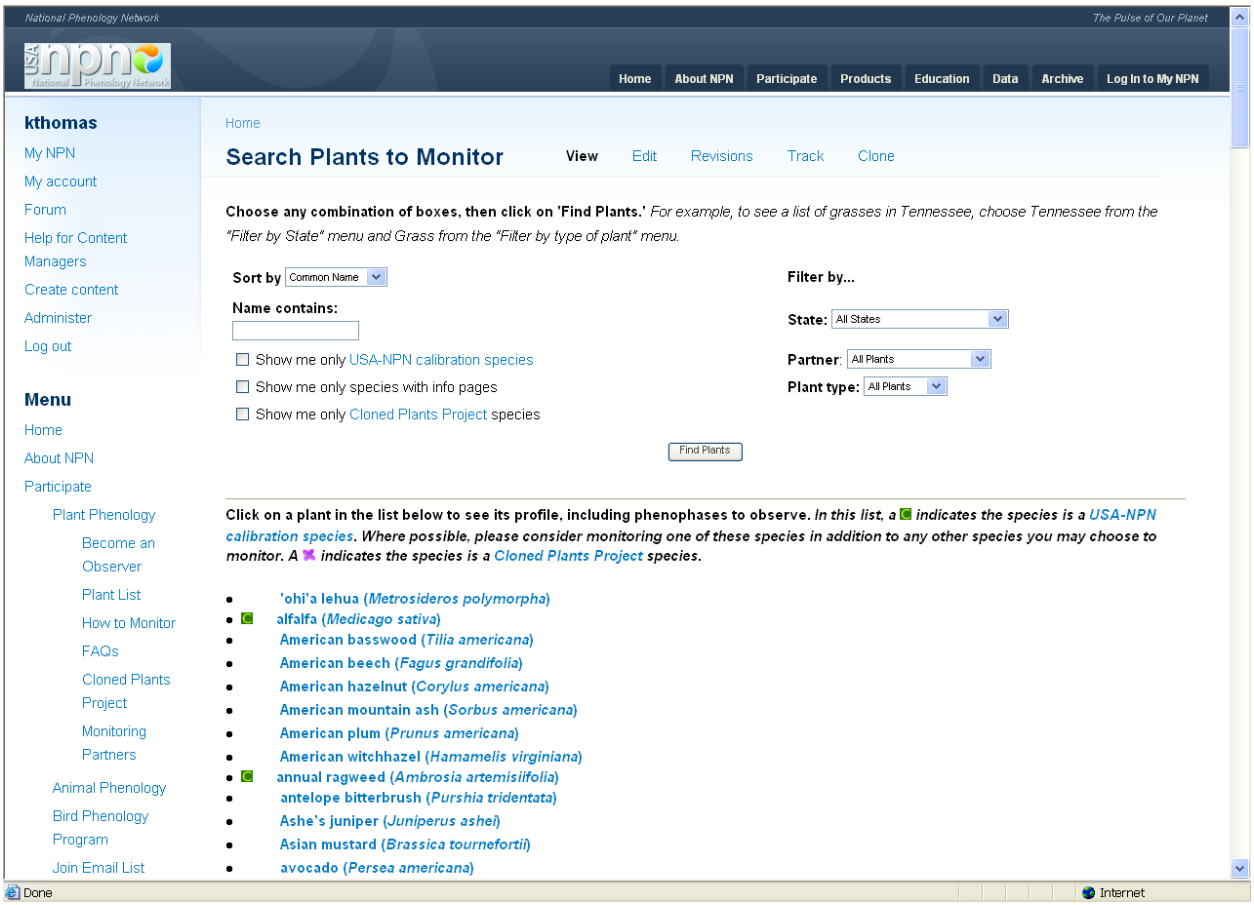
Appendix E Become an Observer

(Screen shot accessed from USA-NPN web site in December 2009)



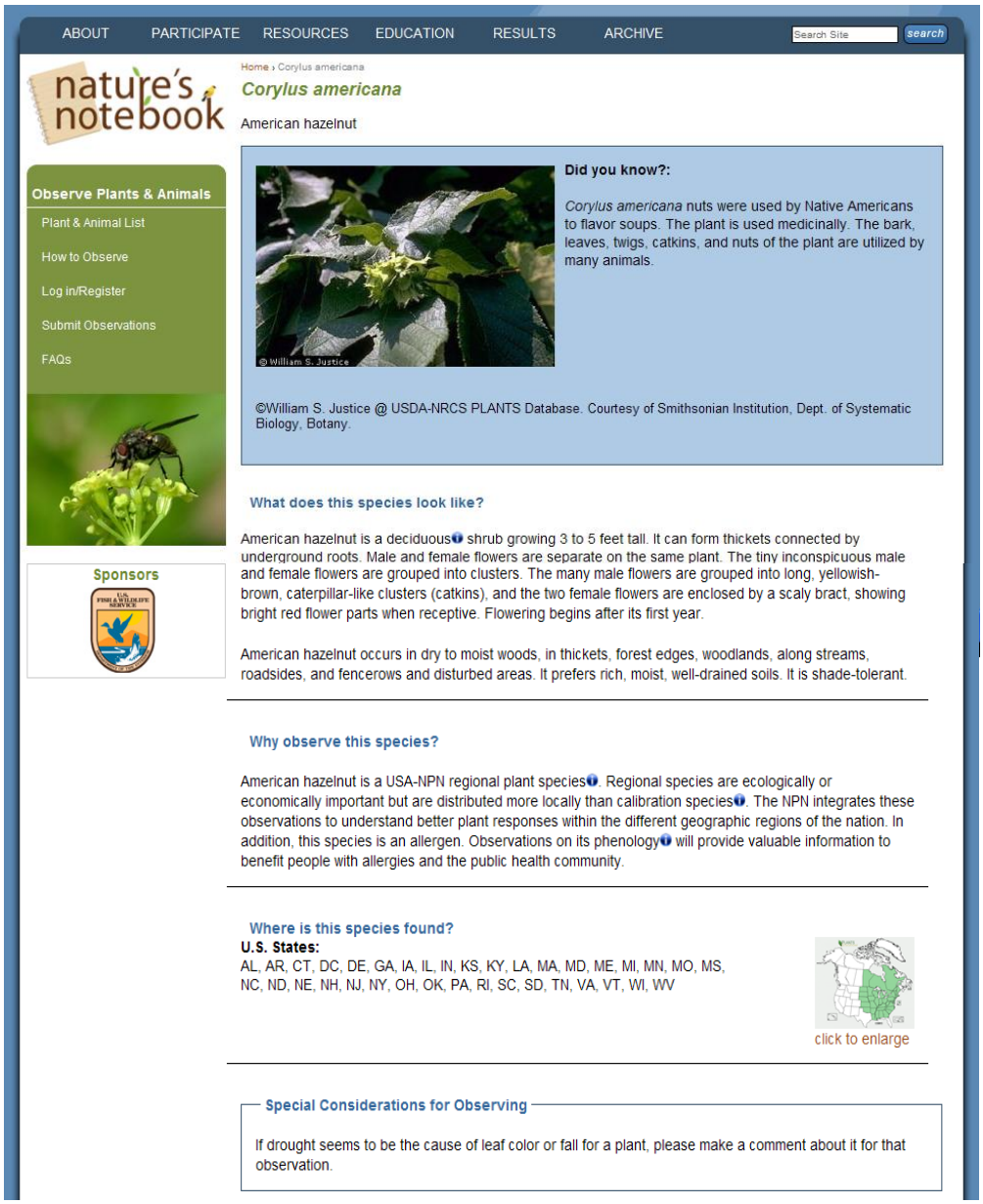
Appendix F Search Plants to Monitor page

(Screen shot accessed from USA-NPN web site in December 2009, list continues beyond screen shoot)



Appendix G Example of a plant species profile page

(Screen shot accessed from USA-NPN web site in December 2009, protocol information on species profile page is not show)



Appendix H How to Monitor

The on-line site provided the following information to the new observer in 2009. Where the online site linked the reader to more information that appeared in the FAQ ('Frequently Asked Questions' page), the FAQ section is indicated in brackets. Text for the FAQ appears in Appendix M.

Selecting a site

First identify the site(s) where the plant(s) you will observe are located, perhaps your front or back yard. Consider these guidelines in selecting your monitoring site(s):

Convenience: You will be visiting your site(s) regularly, so it should be convenient and accessible during the entire growing season.

Representative location: As much as is practical, the selected site(s) should be representative of the vegetation and conditions for your area. ('What is a representative location?', Appendix M)

Uniform habitat: The selected site(s) should be relatively uniform across the site. If you would like to monitor plants in two adjacent habitats, please document them as separate sites. For example, a clearing in forest should be documented as a separate site from the forest.

Appropriate size: A site should be no larger than 15 acres (6 hectares or 250 x 250 meters), a square with sides the length of 2 ½ football fields. A site can certainly be smaller than this, and larger properties can be divided into multiple sites. ('How do I choose an appropriate size for my site?', Appendix M)

Proper permission: If you do not own the property where the site is located, you must get permission from the landowner before marking any plants or reporting the site location information (such as latitude/longitude coordinates). ('Do I need permission to make observations on public land?, Appendix M).

Selecting plant species

Choose one or more plant species to monitor from the USA-NPN plant list (the 'Search Plants to Monitor' page). If possible, choose a USA-NPN calibration species for monitoring in addition to any others you'd like to observe. ('What exactly is a USA-NPN calibration species', Appendix M).

Make sure that you have correctly identified the plant species at your site before reporting your observations for that plant online. ('How do I identify my plant species?', Appendix M)

Selecting individual plants

At your site(s) select one or more individuals of each of your chosen plant species for monitoring. Choose plants that appear to be healthy, physically undamaged, and free of insect or pathogen infestations. For multiple individuals of the same species, try to select individuals that are not direct neighbors, but are still growing in a similar environment. ('How many individuals of the same species should I monitor?' Appendix M).

For annuals (which only survive one growing season) and biennials (which survive for two growing seasons), avoid choosing the first or the last seedling to emerge in the spring since they may not be representative of the larger population at your site. ('Are there other things I should consider when selecting my plant(s)?' Appendix M).

Marking your plants

You will want to somehow mark each individual so that the observations and measurements you make and record through time are always for the same individual plant. We recommend marking each individual plant with a unique label. For example, you could mark pieces of flagging tape with "red_maple_01", "red_maple_02", etc. and then tie them to each of the red maples you are observing.

Possible label materials include flagging tape, popsicle sticks, string, aluminum tags, gardening stakes, and toothpicks. (‘How can I best mark the plant(s) that I am observing?, Appendix M)

Remember that if you do not own the property where your site is located, you must get permission from the landowner to mark any plants.

Getting organized

You will need the following items. You can download and print a field datasheet for each of your plants from the plants' profile page, or generate personalized datasheets for each of your plants from your My NPN Home page.

- Datasheets, clipboard, pencil
- Binoculars (optional, helpful for observing tall trees)
- Marking equipment for first trip

Recording your observations

Check your selected plant's profile page to determine which phenophases you should be observing, and for instructions on how to recognize them. You are not required to follow all of the recommended phenophases for a species, but be sure to note which ones you are and are not following when you enter your observation data (see below).
Observe your plants as often as is possible, ideally at least once a week, but several times a week or even once a day is even better during the spring and fall when things are changing quickly. For each day that you observe a plant, record the date on your datasheet, and for each phenophase, record either:

- Yes (Y) – if you looked for signs and determined the phenophase is occurring
- No (N) – if you looked for signs and determined the phenophase is not occurring
- Unknown (?) – if you did not or forgot to look for signs of this phenophase

It is very important to record this information, even if nothing has changed since your last visit! Knowing when a plant is not in a given phenophase is just as important as knowing when one is. ('Why should I record my observations when nothing has changed since my last observation?, Appendix M)

If a phenophase begins and ends while you were not observing, make a note of it in the comments section. (What if I missed a phenophase?, Appendix M)

If you are watching for a phenophase and it does not seem to be starting when you expect it would, continue to watch for it and record that it is not occurring. This could mean the phenophase is occurring later or not at all in a given year, and this could be very valuable information. ('Why is it valuable to know that a phenophase did not occur at all in a given year?, Appendix M)

Once a phenophase has ended you should continue to look for signs of it and record whether or not it is occurring again. Sometimes phenophases will occur a second or third (or more) time in a season, whether because of rain, pests, or climate change. ('Why should I continue looking for a phenophase even after it has passed?', Appendix M)

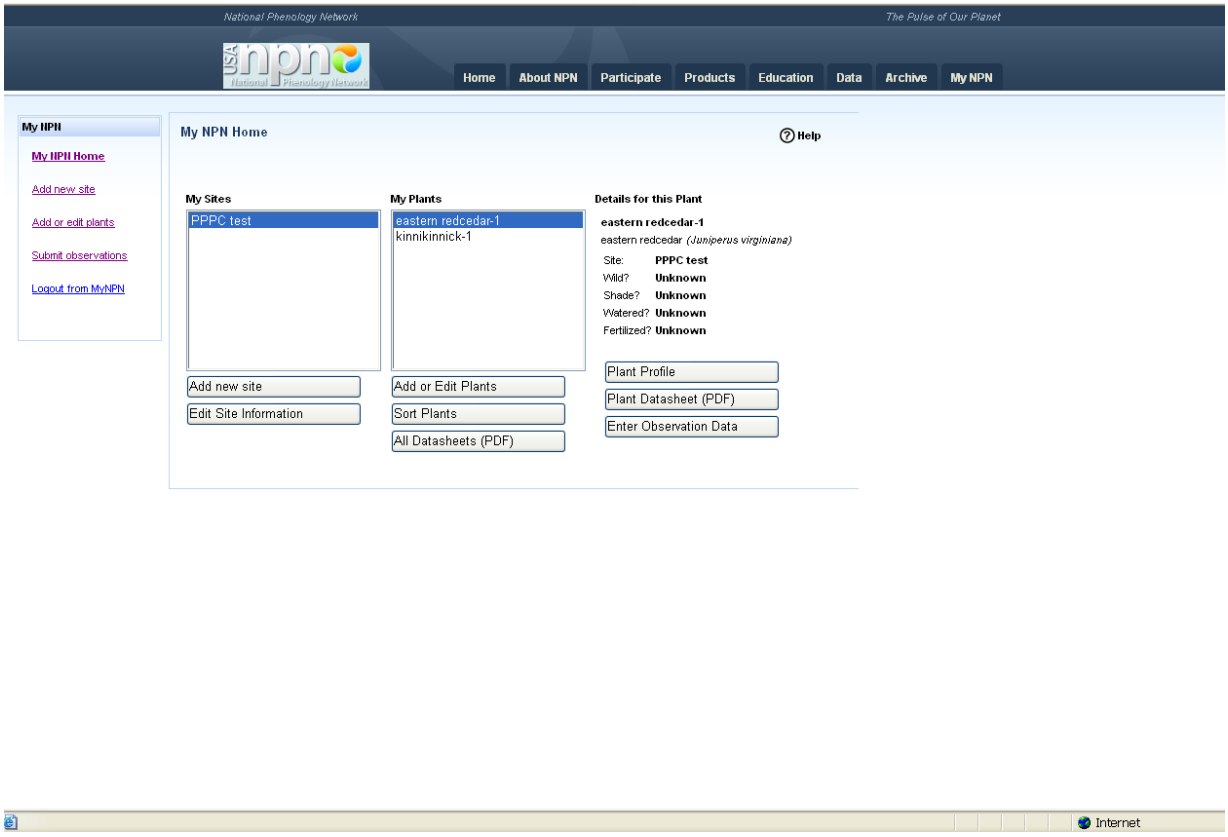
Reporting your data online

As you collect data during the season, login to your My NPN account and enter the observational data you recorded. The sooner you enter your data, the more useful it will be for real-time phenology visualizations.

The value of phenology data is in observations from the same plants over many years, so please come back next season!

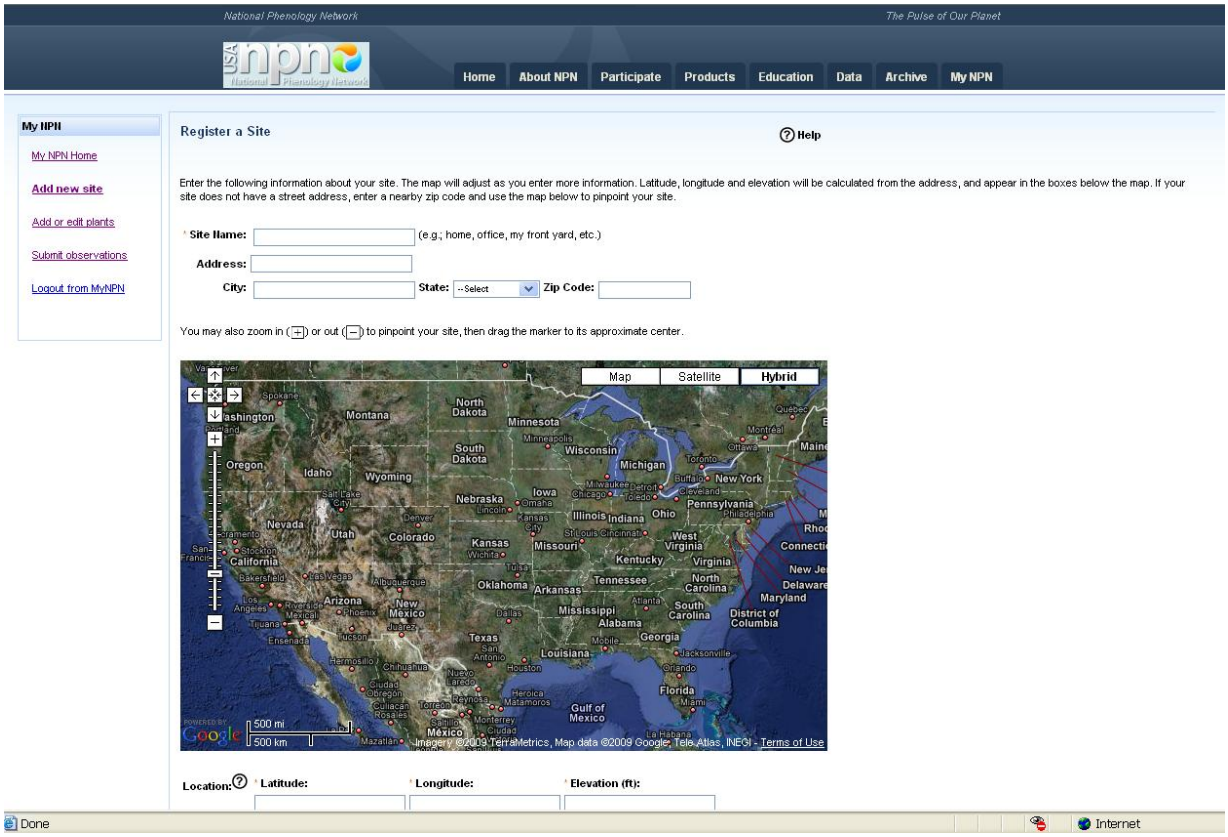
Appendix I MyNPN Home

(Screen shot accessed from USA-NPN web site in December 2009



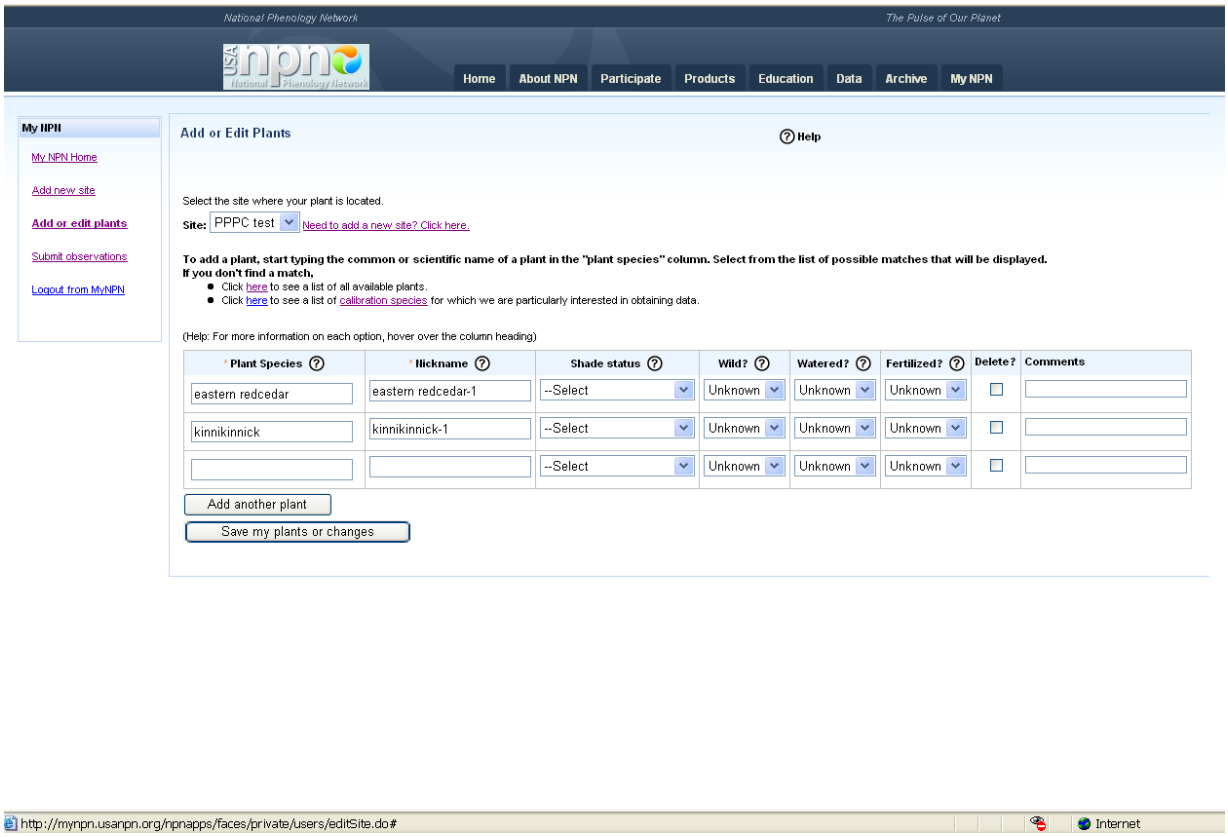
Appendix J Register a Site

(Screen shot accessed from USA-NPN web site in December 2009



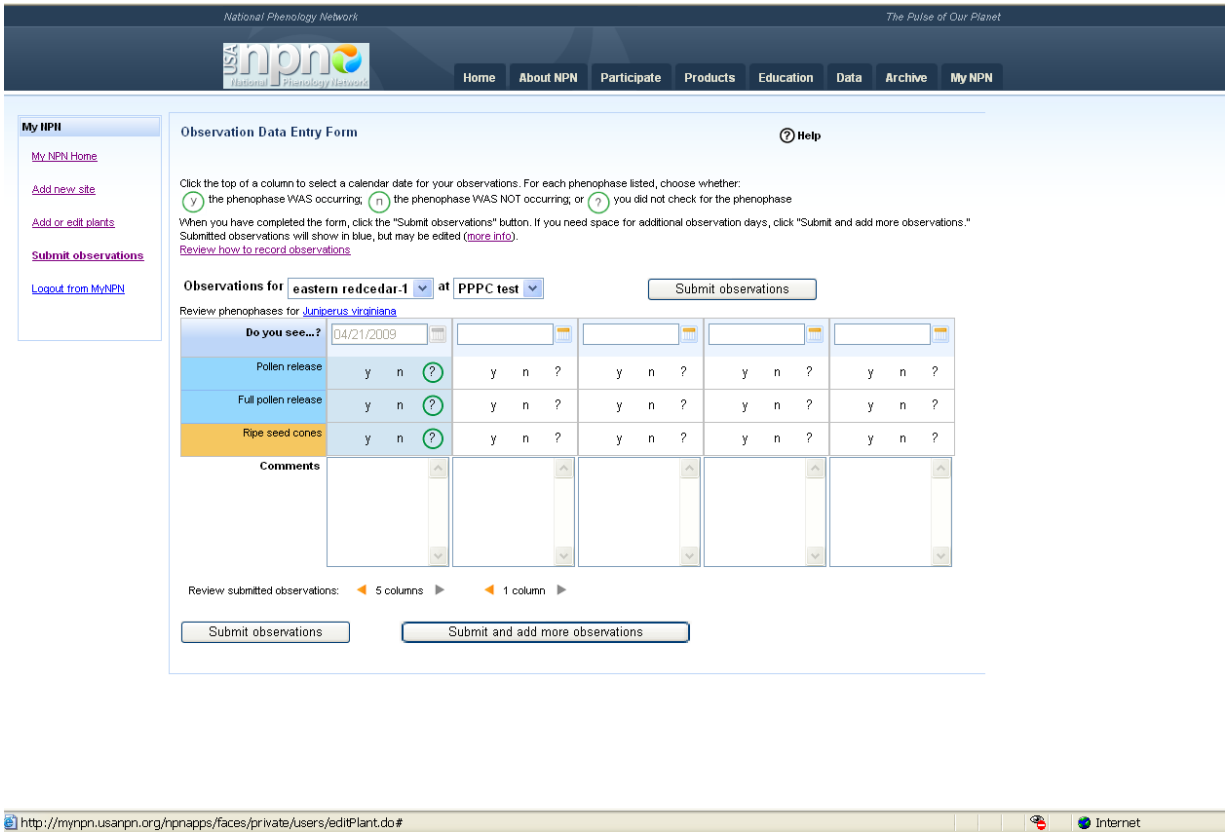
Appendix K Add or Edit Plants

(Screen shot accessed from USA-NPN web site in December 2009



Appendix L Observation Data Entry Form

(Screen shot accessed from USA-NPN web site in December 2009



Appendix M Frequently Asked Questions

(text implemented on-line in 2009)

Site selection

What is a representative location?

Where possible, sites should be relatively flat or gently sloping, and neither excessively dry nor wet for your area. Avoid steep, south-facing or north-facing slopes, and areas that are subject to drifting snow or excessive winds. Avoid locations where plants are given supplemental water or fertilizer. In forested areas, the site should reflect the overall canopy composition and stature/size. However, we welcome all observations, so if your site seems outside of these guidelines, just be sure to record these unusual characteristics in the comments section of the site registration form.

How do I choose an appropriate size for my site?

The size of your sampling site will depend on the scale of your landscape and the proximity of the individuals being observed. Aim to strike a balance between efficiency of observation across the site with the time you have available, and not having the individuals being observed too close together (see How many individuals of the same species should I monitor?). Your monitoring locations should be divided into different sites if their habitats are obviously different.

Do I need permission to make observations on public land?

For public parks or other public lands, you should obtain permission from the appropriate department of the federal government, the state, or the municipality that has responsibility for the property. Land managers often issue hard-copy permits for land access, which will help guarantee the success of your study.

Plant species selection

How do I identify my plant species?

Correct plant identification is important when reporting your observations to the USA-NPN. Before you submit observations for a plant make sure you have identified it as one of the species listed on the USA-NPN list. You may keep track of observations on a datasheet until you have confirmed the plants

identity (see Can I start monitoring a plant if I am unsure which species it is?). The USA-NPN is not staffed to make site visits or to identify plants from photographs, but we will be adding more information to the species profiles to help with identification. In the meantime, there are resources that you can use to help you identify plants of interest.

If you are a beginner to plant identification, you may find that there are many local resources to help you. Often communities have local naturalists and expert gardeners who can provide assistance. The places you may find this help could include: a local native plant society, gardening societies, a master gardener program, state or county cooperative extension office, the botany department of a local college, or professional botanists with state or federal land management agency. Also botanical guides may exist for your state or even your local area that provide useful information.

If you have one nearby, the best place to go is an herbarium where trained botanists offer assistance in identifying plants. A worldwide listing of herbaria is available through the New York Botanical Garden. Search their online database to locate an herbarium in your town or within your state.

Once you identify a person who can help you, you may need to take them a sample from your plant. Do not take a single leaf or flower, but rather break off a twig, stem, or grass blade that includes the point where the leaves and/or flowers are attached. However, do not break off such a large portion of a plant that you are likely to destroy the individual, especially if the plant seems like it might be rare and there are very few other individuals of the same species nearby.

If you do have some idea of what species the plant is and want more information or confirmation, the internet is a good place to start. USDA PLANTS is a database that provides many resources if you know the common or scientific name of a plant. You might also want to try out some of the online plant identification guides. For trees, check out the guide with the Arbor Day Foundation. Or you may want to check out the online guides for all plant types at Discover Life (http://www.discoverlife.org/mp/20q).

Can I start monitoring a plant if I am unsure which species it is?

Yes, you can keep track of observations on a field datasheet, but please do not enter observation data online for a plant until you have identified the species with reasonable confidence. When a plant is

dormant, it may be difficult to tell which species it is, but you probably have a good idea about whether it is an herb, a grass, or a deciduous tree. The phenophase definitions within these broad groups are fairly standard, so we recommend you find a species on the NPN list that is similar to the unidentified one that you are monitoring, and use the datasheet and phenophases for that species (see some choices below).

Once the plant has produced leaves or flowers such that you can identify it, please check the phenophases for that species to make sure they are consistent with what you had been looking for. If so, you can enter all the data online. If not, please do not enter the old observations and just start with the date when you were using the correct phenophase definitions. If it turns out your plant is not on the USA-NPN plant list, please see 'What can I do if the plant I would like to monitor is not on the USA-NPN species list?'

What can I do if the plant I would like to monitor is not on the USA-NPN species list?

The USA-NPN regional species list includes plants of interest due to their dominance, conservation value, association with health issues (such as allergens), or importance to ecosystem services such as food supply. We are working on expanding the list of plants and welcome your suggestions for additions. However, as we make additions to the list, we will not be able to develop the species profiles and monitoring instructions for suggested new plants until later. this year or in 2010.

In the meantime, if you would like to start monitoring a plant not currently on the USA-NPN list, you can use the Project BudBurst monitoring site and protocols. Project Budburst is the general education and outreach program for the USA-NPN and all plant species observations are accepted. The data is incorporated into the same USA-NPN database and if the plant species you have suggested is added to the USA-NPN regional species list in the future, you can switch to using the new monitoring protocols at that time.

Please send your suggestions for new plants to *plants@usanpn.org*.

What exactly is a USA-NPN calibration species?

A USA-NPN plant calibration species is one of 20 plants selected to help "calibrate" phenological measurements across the US These native and introduced plants have broad distributions and are ecologically or economically important. The USA-NPN integrates observations on calibration species to get "the big picture" of plant responses. USA-NPN observers are encouraged to include at least one calibration species in their monitoring projects. Widespread observation of calibration species is needed so that the collective monitoring data for these plants can be integrated with climate measurements across the Nation.

A committee of scientists developed the criteria for calibration species and selected the species. Their list of 20 had widespread review. The criteria for selection were 1) widespread distribution; 2) association with a dominant plant cover type; 3) relationships with other plants and animals; 4) simple identification of species with readily observable phenophases; 5) accessibility to schools and/or population centers; 6) pollinator or wind-borne seed dispersal, and 7) responsiveness to fall as well as spring environmental variables. The species include trees, shrubs, forbs, and grasses. Also, the list represents invasive, allergenic, horticultural, and agricultural species.

Individual plant selection

How many individuals of the same species should I monitor?
For most observers, we recommend monitoring between 1 and 3 individuals of the same species at a site. Observers at research sites may wish to choose 3 to 5 individuals per site. Observing multiple individuals helps to give scientists an idea of the variation in phenology among individuals at your site, however, you will need to consider the number of total individuals available and the time you have to monitor in choosing an appropriate number to observe. If you choose to select multiple individuals to monitor, try to select individuals growing in a similar environment (for example, get similar amounts of sun or shade), but that are not direct neighbors and are separated by at least a few plant widths.

Are there other things I should consider when selecting my plant(s)?
Yes, where possible, try to avoid individuals that are closer than 20 feet to a road or building, or plants that are in dense shade most of the day, such as at the north side of a building, or near a cliff or rock

outcrop. Also, read the species information for your plant(s) to determine if the species has growth characteristics that might affect your selection of the individuals to monitor. For example, some species grow clonally and form large clumps of stems growing from the same roots. If your plant can be clonal, try to choose individual stems from different clumps. Where it is not possible to follow these guidelines for a specific individual, simply mention that in the comments section when you register that plant.

How can I best mark the plant(s) that I am observing?

For trees and shrubs, flagging tape or small, inconspicuous aluminum tags (obtained from a hardware store or forestry supply company) can be attached to each individual, marked in permanent ink. For grasses and forbs, small pins can be placed next to the individuals that will be observed. Some observers have used colored toothpicks as unobtrusive stakes (sometimes hard to spot as vegetation grows) and loosely tied colored string or small plastic flags around the base of individuals. However you mark the location and individual plants, you will want to make sure that the marking does not change the growing conditions of the plant. For example, avoid placing a broad stake next to a small plant that would shade it or cause root damage. Markers may need to be replaced periodically as they weather and become unreadable.

What if the plant I am observing dies?

If an individual dies or is obviously declining in health (when others of the same species around it are still healthy), you should select a new individual to monitor. However, be sure to note the death in the comments section and to give the replacement a new, unique label. If you are monitoring any annual or biennial species at your site, this procedure will need to be followed regularly since the individual plants die after one and two seasons, respectively.

Cloned lilac plants

I requested cloned lilacs but have not received them. What is the status of my request?

We still have more requests for cloned lilac plants than we can immediately satisfy. The number that we can distribute each year is limited by available funds. We are trying to fill requests in a way that will

distribute cloned lilacs to all areas across the country, but also send them as soon as possible to those interested in receiving them.

Another option for observers who want to obtain cloned lilacs as quickly as possible, and are willing to help us stretch our limited resources, is to purchase them directly from the supplier, Jung Seed Company. Orders can be placed through Jung's web page or by calling their order department at 1-800-247-5864.

As a third option, you may purchase a common purple lilac (*Syringa vulgaris*, usually called "old fashioned" or "hedge") from any nursery and observe it while waiting to get your cloned lilacs. Common purple lilacs make good "partners" with cloned lilacs, as their responses are quite similar."

What type of lilac do I have? Aren't the cloned lilacs you sent me common lilacs?
No. The cloned lilacs you (or a previous observer) received from us (or as part of legacy eastern USA lilac networks) are not common lilacs! They are Chinese lilacs (*Syringa chinensis* 'Red Rothomagensis'), which have leaves that are about twice as long as they are wide (much narrower than common purple lilac leaves). As mentioned above, common purple lilacs (*Syringa vulgaris*, also called "hedge" or "old-fashioned") are those that observers have obtained on their own from nurseries, or already had growing on their grounds. Although these plants are NOT clones, their response is generally quite uniform. Common lilacs have leaves that are somewhat "heart" shaped (much wider than cloned lilac leaves).

Making observations

How often should I record my observations?
As often as it is convenient for you. Ideally, observations should be recorded at least once a week or even as frequently as every 2 or 3 days, particularly during the spring and fall when plants are changing quickly. But the critical thing is to record observations as often as is convenient for you—your observations, no matter how often you make them, provide valuable data.

Why should I record my observations when nothing has changed since my last observation?
Having a full record of your observation dates allows someone using your data to more confidently narrow down the exact date a phenophase began or ended. For example, if you record that you saw emerging leaves on your April 6 visit, and your last recorded visit was April 2, where when you reported that you did not see them, then we know that this phenophase must have begun some time within those 4 to 5 days. If you only record the April 6 visit and no previous visit, we only know that leaves started to emerge sometime between April 6 and the previous winter. This example also illustrates why more frequent observations are useful when a phenophase is expected to begin or end—if you can check every 2 or 3 days, it allows you to provide a more precise estimate of which day a phenophase actually started or ended.

What if I missed a phenophase?
If you miss the occurrence of a phenophase entirely (for example, flowering started and ended while you were away on a 10 day vacation), yet you see evidence that it did indeed happen (such as dried flowers on the ground below the plant), then make a note of this in the comments section for your next observation of that phenophase.

Why is it valuable to know that a phenophase did not occur at all in a given year?
It is not uncommon for some species, especially some trees, not to flower and fruit every year, and information about which years had obvious flowers or fruits and which years did not can be very important to scientists studying the insects and animals that depend on them.

Why should I continue looking for a phenophase even after it has passed?
In some dry climates, phenophases start anew with each rainstorm. Even in temperate regions, where most plant phenophases predictably begin and end only once in a season, climate change may bring substantial changes to the timing of life cycle events, which is extremely important to capture! For example, more frequent late frosts or insect defoliation events may cause an increase in multiple episodes of leaf budburst for a given plant species in a single season.

Can I still report 'Emerging leaves/needles/growth' once I see 'Unfolded or Young unfolded leaves/needles' on the plant?

Yes, you should judge each leaf bud, needle bud or shoot separately. As long as some buds or shoots are still opening or emerging and have not yet produced an unfolded leaf or needle, you are seeing emerging leaves, needles or growth on the plant. For plants that have more than one bud or shoot, in most cases you will still be seeing 'Emerging leaves/needles/growth' for many days after you first begin seeing 'Unfolded or Young unfolded leaves/needles'. It is also possible to see multiple episodes of leaf emergence within a season, while unfolded leaves are still present on the plant. This might occur after a period of severe drought or after an insect defoliation event.

How can I judge when a leaf is '≥75% of full leaf size'?

We recognize this will be a rather subjective estimate on the observer's part when there are no mature leaves on the plant for comparison, but just try your best. You could measure full leaf size during summer of the first year and then use that measure to better judge 75% of full leaf size for subsequent years. We are asking observers to note when leaves become 75% of full leaf size in order to create an estimate of the point in time when leaves are almost, but not quite full size. Including this measure in the phenological record for your plant allows scientists to keep track of the length of the "green-up" period (the time is takes leaves to develop to full size), which is an important aspect of the response of a plant to climate change.

Reporting your data online

How do I change data once I have entered it?

If you wish to correct observation data for a particular day, navigate to that day using the arrows below the observation interface. Then change the Yes, No and '?' responses to the correct ones for that day. Unfortunately, you cannot edit the day for which the observations are reported. If you have correct data entered for the wrong day, then change the wrong response(s) to a ? (didn't check) and add a new day with the correct response(s). Adding a comment to the wrong submission describing that correction will help us keep track of your change.

Appendix N 2009 Field Data Sheets

On the following pages are the general datasheets for the plant groups. Datasheets were available to observers on the species profile page and on the MyNPN account pages for the observers registered plants. Where the phenophases have been modified for a plant group or a species, the datasheet specific to the plant was provided instead of the general datasheets.

The datasheets following are for the following groups:

- Deciduous trees and shrubs (with flowers)
- Deciduous trees and shrubs (with catkins)
- Broadleaf evergreen trees and shrubs
- Conifers
- Herbs
- Grasses
- Cacti
- Lilacs and honeysuckles

Deciduous trees and shrubs (with flower observations)

Phenology Field Monitoring Datasheet

USA npn National Phenology Network

Species:_____ Plant Nickname: _____ Plant Site: _____ Year: _____ Observer: _____

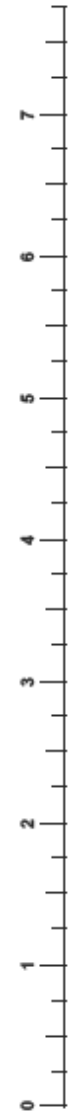
Fill in the date in the top row and circle the appropriate letter in the column below it: **y** (phenophase occuring); **n** (phenophase not occuring); or **?** (did not check for phenophase).

Do you see...? / Date																
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥75% of full leaf size	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? / Date																
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥75% of full leaf size	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments



Deciduous trees and shrubs (with pollen observations)

Phenology Field Monitoring Datasheet

USA npn National Phenology Network

Species:_____ Plant Nickname: _____ Plant Site: _____ Year: _____ Observer: _____

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...? / Date																
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥75% of full leaf size	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? / Date																
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥75% of full leaf size	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves colored	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
≥50% of leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves fallen	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Broadleaf Evergreens

Phenology Field Monitoring Datasheet

USA npn National Phenology Network

Species:____________________ Plant Nickname: ________________ Plant Site: ________________ Year: ______ Observer: ________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...? Date															
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open Flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open Flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open Flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Conifers

Phenology Field Monitoring Datasheet

Species:______________________ Plant Nickname: __________________ Plant Site: __________________ Year: ______ Observer: ___________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...?	Date														
Emerging needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seed cones	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Emerging needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seed cones	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Emerging needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Young unfolded needles	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full pollen release	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seed cones	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Herbs

Phenology Field Monitoring Datasheet

Species:________________________ Plant Nickname: ___________________ Plant Site: ___________________ Year: _______ Observer: ___________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Grasses

Phenology Field Monitoring Datasheet

Species:________________________ Plant Nickname: ___________________ Plant Site: ___________________ Year: _______ Observer: ______________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seeds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seeds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...? Date															
Emerging growth	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Unfolded leaves	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves withered	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe seeds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Cacti

Phenology Field Monitoring Datasheet

USA npn National Phenology Network

Species:______________________ Plant Nickname: __________________ Plant Site: __________________ Year: ______ Observer: ____________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...?	Date														
Flower buds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Flower buds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Flower buds	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Ripe fruits	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Lilacs & Honeysuckles

Phenology Field Monitoring Datasheet

USA npn National Phenology Network

Species:______________________ Plant Nickname: __________________ Plant Site: __________________ Year: ______ Observer: ____________________________

Fill in the date in the top row and circle the appropriate letter in the column below it: y (phenophase occuring); n (phenophase not occuring); or ? (did not check for phenophase).

Do you see...?	Date														
Emerging leaves (prev. "First leaf")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves emerged (prev. "Full leaf out")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers (prev. "First bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering (prev. "Full bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
End of flowering (prev. "End bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Emerging leaves (prev. "First leaf")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves emerged (prev. "Full leaf out")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers (prev. "First bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering (prev. "Full bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
End of flowering (prev. "End bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments

Do you see...?	Date														
Emerging leaves (prev. "First leaf")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
All leaves emerged (prev. "Full leaf out")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Open flowers (prev. "First bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Full flowering (prev. "Full bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
End of flowering (prev. "End bloom")		y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?	y n ?
Check when data entered online:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments